REMARKS

Claims 1-3 were rejected under 35 U.S.C. §103(a) as being unpatentable over Applicant admitted prior art (AAPA) in view of Itou et al., U.S. Patent No. 6,556,260.

Claims 4-5, 7-9, 12 and 16 were rejected under 35 U.S.C. §103(a) as being unpatentable over AAPA in view of Shirasaki et al., U.S. Patent No. 6,025,894 and Itou et al.

Claim 18 was rejected under 35 U.S.C. §103(a) as being unpatentable over Shirasaki et al. in view of Itou et al.

Claims 10-11, 13-14, 17 and 19 were rejected under 35 U.S.C. §103(a) as being unpatentable over AAPA, Shirasaki et al. and Itou et al., and further in view of Avramenko et al., U.S. Patent No. 4,142,773.

Applicant encloses herewith a Declaration Under 37 C.F.R. 1.131, which shows conception prior to March 15, 2000, the U.S. filing date of Itou et al., which is the effective date of Itou et al. as a reference, and diligent reduction of the invention to practice, the reduction of the invention to practice being by the filing of the priority document herein, Japanese Patent Application No. 2000-125056, filed on April 26, 2000, a certified English translation of that priority document being attached to the Declaration. Based on conception prior to March 15, 2000, and diligent reduction to practice of the invention shown by the aforementioned Declaration, Itou et al. is overcome as a reference, and the pending rejections should be withdrawn, see Manual of Patent Examining Procedure, §715.

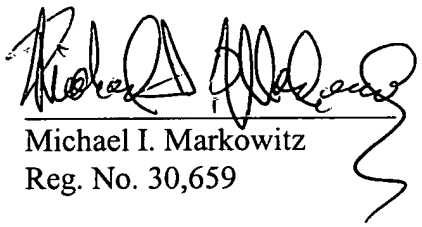
CLOSING

An earnest effort has been made to be fully responsive to the Examiner's objections. In view of the above remarks, it is believed that independent claims 1, 9, 16, and 18 are in condition for allowance, as well as those claims dependent therefrom. Passage of this case to allowance is earnestly solicited.

However, if for any reason the Examiner should consider this application not to be in condition for allowance, he is respectfully requested to telephone the undersigned attorney at the number listed below prior to issuing a further Action.

Any fee due with this paper, not fully covered by an enclosed check, may be charged on Deposit Account 50-1290.

Respectfully submitted,



Michael I. Markowitz
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Enclosure: Declaration Under 37 C.F.R. 1.131

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DOCKET NO.:NECN 18.617
MIM:lh

1115977003

Attorney Docket No.:NECN 18.617 (100933-16782)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor:	Ichiro FUJIEDA
Serial No.:	09/842,580
Filed:	April 26, 2001
Title:	**LIQUID CRYSTAL DISPLAY DEVICE HAVING A FRONT LIGHT UNIT**
Examiner:	Mike Qi
Group Art Unit:	2871

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. 1.131

S I R :

I, Ichiro Fujieda, inventor named in the above-captioned application, declare as follows:

1. The invention for which a patent is sought in the above-captioned application was conceived prior to March 15, 2000, as evidenced by a Japanese language Employee's Invention Report-Assignment-Opinion dated February 14, 2000, and a draft specification by the inventor referred to in the Employee's Invention Report-Assignment-Opinion are attached hereto respectively as Exhibits "A" and "B". English translations of the Employee's Invention Report-Assignment-Opinion and the draft specification by the inventor are also attached hereto respectively as Exhibits "C" and "D".

2. The invention disclosed in the above-mentioned draft specification by the inventor was diligently reduced to practice.

3. Evidence of the diligent reduction of the invention to practice includes a request for the drafting of a patent application from NEC Corporation, the assignee of the above-captioned application, to the Yanagawa Patent Firm, dated March 2, 2000. The Japanese language original of this request for the drafting of a patent application is attached hereto as Exhibit "E", and the English translation thereof is attached hereto as Exhibit "F". In addition, the Japanese language original of an approval of the draft specification by the inventor, dated April 21, 2000, is attached hereto as Exhibit "G", and the English translation thereof is attached hereto as Exhibit "H".

4. An English translation of the priority document filed herein, Japanese Patent Application No. 2000-125056, along with a certification of that translation, the priority document being filed on April 26, 2000, is attached hereto as Exhibit "J".

I further declare that all statements made herein are of my own knowledge are true and all statements made on information and belief are believed to be true; and further, these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code, and

that such willful false statements may jeopardize the validity of the above reference application or any patent issuing thereon.

DATE: March 3, 2004

Ichiro Fujieda

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DOCKET NO.:NECN 18.617
MIM:lh

業務発明届出・譲渡・意見書

（ＮＥＣ単独出願）

【発明者記入欄】

2000年02月14日

仮番号	11135819	発明の名称　フロントライト及び液晶表示装置	
整理番号	348-03411		

発明者						
	確認	会社コード 社員番号	氏名 ローマ字（外国出願に用いるため）	電話　地区一番号 外線ダイヤルイン	Ｅメールアドレス 外線ＦＡＸ番号	会社名 所属部門名
1	済	0000 0874082	藤枝　一郎 Ichiro Fujieda	272-3070 044(856)8138	fujieda@ddl.cl.nec.co.jp 044(856)2097	日本電気株式会社 機能デバイス研究所ディスプレイ・デバイス研究部

届出の形態	○発明説明書（実施の形態・図面等）による届出 ●明細書全文による届出 ○コンカレント	
外国出願	●希望する ○希望しない	出願希望国　アメリカ
国内優先権主張	○自発的 ○知的財産部の要請 ●希望しない	先の発明の出願番号 先の発明の出願日　　年　月　日（西暦８桁で記入のこと） 先の発明の整理番号 知的財産部要請日　　年　月　日（西暦８桁で記入のこと）
社外発表出荷予定	○製品発表 ○論文発表 ○新聞発表 ○その他 ●社外発表なし	製品名 学会名 発表予定日　　年　月　日（西暦８桁で記入のこと）
	□製品出荷	製品出荷先 出荷予定日　　年　月　日（西暦８桁で記入のこと）
関連発明（あれば入力）	出願番号 出願日　　年　月　日（西暦８桁で記入のこと） 整理番号 外国出願してあればその国名	
発明の種類	○ビジネスの方法（やり方や仕組み）に関する発明である ●その他の発明である	

譲　渡

上記の発明について、日本電気株式会社従業員就業規則にもとづいて、 特許または実用新案登録を受ける権利を日本電気株式会社に譲渡いたします。

EXHIBIT "A"

【所属部長意見記入欄】

2000年02月14日

権利の帰属	発明をするに至った行為が現在または過去の職務に ●属する ○属しない
関連するプロジェクト	プロジェクトの名称
	○重要開発プロジェクト ●左記以外のプロジェクト ○該当なし
特定得意先との関係	□防衛庁 □ＮＴＴ □通産省 □ＪＲ □ＮＰ(National Project)

発 明 の 評 価

1. **登録の可能性**
   ○８０％以上 ●６０～８０％ ○３０～６０％ ○３０％以下 ○可能性なし

2. **アイデアの性質（複数選択可）**
   □技術コンセプトが新しい □このアイデアの実現が望まれる
   □今後重要になる技術の先取り □新規機能を提供する ■優れた代替手段を提供する

3. **基本／改良**
   ○全くの基本発明 ○どちらかといえば基本発明
   ●本格的改良発明 ○部分的改良発明

4. **技術的効果**
   ○きわめて大 ●大 ○普通 ○小

5. **実施見込み（社外を含む）**
   ○実施決定 ○試作中 ○試作中（出荷予定なし） ●５年以内に実施の可能性あり ○不明
   年 月 日出荷予定（西暦８桁で記入すること）

6. **汎用性（他の技術領域に応用できる可能性）**
   ○高い ●普通 ○低い

7. **技術の寿命**
   ●長い ○中程度 ○３年以下

8. **回避の可能性**
   ○不可能 ●かなり困難 ○可能性あり ○容易

9. **侵害の確認**
   ●容易 ○かなり困難 ○きわめて困難

総合評価	●Ａ ○Ｂ１ ○Ｂ２

外国出願	●する　○しない
出願国	A項の国の□部分をクリックし、選定理由としてB項の該当する数字を（ ）内に入力する。 なお、４および５項の競争会社名も同じ（ ）内に入力

A　国名		B　理由
■アメリカ	US（ 1 ）	1．この発明を実施した製品を輸出する見込みがある。
□韓国	KR（ ）	2．この発明を実施した製品を現地生産する見込みがある。
□中国	CN（ ）	3．この発明に関する技術を技術輸出する見込みがある。
□台湾	TW（ ）	4．この発明に関係する機種につき当社がライセンスを受けている相手方が 企業活動をしている（会社名をA項の（ ）内に記入）
□イギリス	GB（ ）	
□ドイツ	DE（ ）	
□フランス	FR（ ）	5．この発明を実施した製品の分野で競争関係にある会社がある。（会社名をA項の（ ）内に記入）
□イタリア	IT（ ）	6．その他上記以外の理由があれば（ ）に記入）
□スエーデン	SE（ ）	
□オランダ	NL（ ）	
□カナダ	CA（ ）	
□オーストラリア	AU（ ）	
□シンガポール	SG（ ）	
□マレーシア	MY（ ）	
□タイ	TH（ ）	
□フィリピン	PH（ ）	
□インドネシア	ID（ ）	

所属部長決定	届出：本発明は特許性があると判断しますので出願を依頼します。 ●届出可 ○公開技報　○併合による中止 ○併合以外の理由による中止 所属部長　社員番号 0498644　氏　名：葉山　浩

【選別責任者記入欄】

2000年02月14日

選別責任者入力欄	○S級とする ●届出可　○公開技報　○併合による中止　○併合以外の理由による中止 選別責任者（不在のときは発明者の所属部長）　社員番号 0498644　氏　名：葉山　浩

【備考欄】

備　考	知的財産部への要望

【書類名】明細書

【発明の名称】

フロントライト及び液晶表示装置

【特許請求の範囲】

【請求項1】

複数の反射手段を有する液晶表示装置と，該液晶表示装置の表示面の前方に配置されて，該複数の反射手段の方向へ光を発する照明手段を有する液晶表示装置において，

前記照明手段が，複数の光を発する領域と，複数の光を透過する領域とを有することを特徴とする液晶表示装置。

【請求項2】

前記照明手段の前記光を発する領域の前記液晶表示装置へ対向しない側の表面が，光を吸収する性質を持つことを特徴とする請求項1記載の液晶表示装置。

【請求項3】

前記液晶表示装置の前記複数の反射手段が第一の配列間隔で配置され，前記照明手段の前記複数の光を発する領域と前記複数の光を透過する領域とが第二の配列間隔で配置され，前記第二の配列間隔は前記第一の配列間隔の整数倍であることを特徴とする請求項1記載の液晶表示装置。

【請求項4】

前記液晶表示装置の前記複数の反射手段の配列方向と，前記照明手段の前記複数の光を発する領域の配列方向とが，互いに0でない角度を成すことを特徴とする請求項1記載の液晶表示装置。

【請求項5】

前記照明手段の前記複数の光を発する領域を2つ以上の複数のグループとして独立に制御する手段を有することを特徴とする請求項1記載の液晶表示装置。

【請求項6】

前記照明手段が，透明電極と有機EL材料と不透明電極とを積層した構造を透明基板上に有することを特徴とする請求項1記載の液晶表示装置。

【請求項7】

前記照明手段の製造工程が，前記透明基板上に前記透明電極を形成する工程と，前記有機EL材料を形成する工程と，前記有機EL材料の上部にパターニングされた不透明電極を形成する工程を含むことを特徴とする請求項2記載の液晶表示装置。

【発明の詳細な説明】

【発明の属する技術分野】

本発明は，携帯電話，携帯情報端末，ノートパソコン，等の機器に搭載される液晶表示装置に関するもので，特に，補助光源としてフロントライトを用いた反射型液晶表示装置に関するものである。

【従来の技術】

従来から，フロントライトを用いた反射型液晶表示装置が公開特許公報 特開2000-29008，特開2000-19330，特開平11-326903，等に開示されている。これらのフロントライトを用いた反射型液晶表示装置について，特開2000-29008に開示されている構成を例に挙げて説明する。従来のフロントライトを用いた反射型液晶表示装置は，反射電極122等を含む液晶表示装置120とフロントライト110とを，図12に示すように重ねて構成される。フロントライト110は，冷陰極管，あるいは，発光ダイオード(LED)等を線状に配列して構成した線状光源111を，導光体112の端部に配置して構成される。更に，この例では，液晶表示装置120に対向しない側の導光体112の側面に階段状の加工を施し，更にその上部に保護部材113を配置する。

動作は以下の通りである。光源111から発せられた光は，導光体112の側面112aから内部へ侵入し，反射面112bで進路を変更された後に，出射面112cから放出されて，液晶表示装置120に入射する。液晶表示装置120に入射した光は，偏光板124，位相差板125，透明基板124，液晶123を順に透過した後に反射部材122で反射され，反射光はこれらの部材を逆の順に透過して，液晶表示装置120から放出される。ここで放出される光の量は，反射部材122の上部に存在する液晶分子の配列方向によって制御されるので，液晶に印加する電圧を個々の反射部材について個別に制御することで，任意のパターンを表示することができる。液晶表示装置120から放出された光は，フロントライト110を透過した後に，(不図示の)観察者に至る。更に，図12の構成では，保護部材113によって反射面112bの損傷が防止される。

【発明が解決しようとする課題】

フロントライトを用いた従来の反射型液晶表示装置は，導光体の端部に配置された光源から発せられた光が導光体内部を伝播し，導光体の表面で進路を変えられた光が反射型液晶表示装置を照明する構成である。ここで，導光体から光を取り出すための仕組み(階段状，あるいはプリズム状の表面加工など)の設計が重要であるが，液晶表示装置の全表示領域に渡って均一に照明することは困難である。

また，このような光を取り出すための仕組みは，周囲の外光を反射させて表示するときにも，外光の進路をも変えるため，補助光源としてのフロントライトを使用しないときの表示性能を劣化させることがある。

更に，フロントライトの導光体の表面にゴミや油等の異物が付着すると，その部分で余分に光が散乱されるため，均一な照明が困難になるという課題がある。

また，光源から発せられた光は，液晶表示装置へ対向しない導光体の側面からも漏れ出るため，光の利用効率が低い。

更に，例えば携帯電話の表示機能で一般的になっているように，時間や通信環境の状態等の情報を，一部の表示領域のみを用いて表示する機能(以下では，“パーシャル表示”と呼ぶ)を持つ液晶表示装置があるが，従来の構成のフロントライトでは，表示したい領域のみを選択して照明することはできない。

本発明は上記の事情のもとに考案されたものであり，効率良く均一に液晶表示装置を照明でき，異物が付着しても表示性能に大きな影響を与えないフロントライトを備えた反射型液晶表示装置を低コストで実現することを目的としている。また，パーシャル表示機能を備えた反射型液晶表示装置を低コストで実現することを目的とする。

【課題を解決するための手段】

本発明に係る請求項1記載の液晶表示装置は，反射型液晶表示装置の表示面の前方に配置されて，反射型液晶表示装置の方向へ光を発する照明手段を有し，上記照明手段が，複数の光を発する領域と，複数の光を透過する領域とを有することを特徴とする。

本発明に係る請求項2記載の液晶表示装置は，上記照明手段の光を発する領域の反射型液晶表示装置へ対向しない側の表面が，光を吸収する性質を持つことを特徴とする。

本発明に係る請求項3記載の液晶表示装置は，反射型液晶表示装置の複数の反射手段が第一の配列間隔で配置され，上記照明手段の複数の発光領域が第二の配列間隔で配置され，上記第二の配列間隔は上記第一の配列間隔の整数倍であることを特徴とする。

本発明に係る請求項4記載の液晶表示装置は，反射型液晶表示装置の複数の反射手段の配列方向と，上記照明手段の複数の発光領域の配列方向とが，互いに0でない角度を成すことを特徴とする。

本発明に係る請求項5記載の液晶表示装置は，上記照明手段の複数の発光領域を2つ以上の複数のグループとして独立に制御する手段を有することを特徴とする。

本発明に係る請求項6記載の液晶表示装置は，上記照明手段が，透明電極と有機EL材料と不透明電極とを積層した構造を透明基板上に有することを特徴とする。

本発明に係る請求項7記載の液晶表示装置は，上記照明手段の製造工程が，透明基板上に透明電極を形成する工程と，有機EL材料を形成する工程と，上記有機EL材料の上部にパターニングされた不透明電極を形成する工程を含むことを特徴とする。

【発明の実施の形態】

(本発明の構成の第一の実施の形態)

図１は，本発明の第一の実施例について，その主要な構成要素とそれらの配置とを模式的に示した説明図である。本発明の液晶表示装置は，図1(a)に示すように，液晶表示装置20にフロントライト10を重ねて構成される。ここで，図1(b)の断面図に示すように，フロントライト10は，透明基板11の上に透明電極12，有機材料から成るエレクトロルミネセンス（EL）層13，不透明電極14を順に積層して形成して構成される。フロントライト10の表面には保護層15が設けられる。更に，液晶表示装置20は，複数の反射部材22，配向膜23を有する透明基板21と，カラーフィルタ26，配向膜25を有する透明基板27とで，液晶24を挟んで構成される。更に，図2は，フロントライト10の不透明電極14と，液晶表示装置20のカラーフィルタ26との位置関係を示す説明図である。フロントライト10の不透明電極14は，図3に示すようにメッシュ状の形状であり，電圧を印加するための接続用の端子が形成されている。図2の例では，フロントライト10の不透明電極14の桝目一つが，液晶表示装置20の4つの画素に対応して形成されている。図2に模式的に示すように，不透明電極14が占有する面積の比率は極めて小さくする。図4は，フロントライト10の2つの電極（不透明電極14と透明電極12）へ電圧を印加するための端子の近傍の構成を説明するための説明図である。図4に示すように，透明電極12は透明基板11の表面に一様に形成され，絶縁層でもある有機EL層13によって端子部を除いてその全面を覆われる。その上に形成されるメッシュ状の不透明電極14は，透明電極12と接することはない。

フロントライト10と液晶表示装置20とは，空気層を挟んで保持されても良いし，屈折率が透明基板と同程度の光学接着剤を用いて固定しても良い。

更に，具体的な材料，製法，数値例を挙げて，以下に本発明の実施の形態について詳細に説明する。フロントライト10の透明基板11として，厚さ0.3～1mm程度のガラス，プラスチック基板，フィルム基板，等が使用できる。透明電極11としては，酸化インジウム錫合金(ITO)等を透明基板11の全面にスパッタ法により成膜して形成する。透明電極11の材料としてITO を用いた場合は，シート抵抗20/□程度，厚さは100nm程度に形成する。有機EL層13としては，発光層と正孔注入輸送層からなる2層構成，これに電子注入輸送層を加えた3層構成，更に金属電極との界面に薄い絶縁膜を配置した構成，等が知られており，これらの構成のどれでも図1(b)の構成に適用できる。即ち，図1(a)では単に有機EL層13として示しているが，細かく見ればこのような様々な構成が可能である。有機EL層13の製造方法は，スピンコーティング法，真空蒸着法，インクジェット印刷法，等が知られており，それぞれの製造方法に対応して，高分子系か低分子系か等の有機EL材料の選択，下地の構造，上部電極の製造方法，等の製造条件が決められる。この実施例においては，有機EL層13は，正孔注入輸送層の材料としては，例えばトリアリールアミン誘導体，オキサジアゾール誘導体，ポルフィリン誘導体，等，発光層の材料として，例えば8-ヒドロキシキノリン及びその誘導体の金属錯体，テトラフェニルブタジエン誘導体，ジスチリルアリール誘導体，等，をそれぞれ真空蒸着法により各々50nm程度の厚さに積層して形成するものとする。このとき，金属製のシャドウマスクを用いて，図4に示した透明電極12の端子部には有機EL材料が蒸着されないようにする。尚，これらの材料により光の波長が選択できる。この例では，光の3原色に対応して，波長が450nm，540nm，630nm近辺にピークを持つ3つの成分を持つように，有機EL層13の材料を選び形成する。不透明電極14は，アルミニウムーリチウム合金，等の材料を，金属のシャドウマスクを通して厚さ200nm程度に真空蒸着する等して形成する。最後に，有機EL層13を酸素や湿気から保護する目的で，金属酸化物，金属硫化物，等からなる保護層15を全面に設ける。あるいは，保護層15の代わりに，プラスチック製のカバーで素子全体を覆い，窒素やアルゴン等の不活性ガスで空気を置換して封止層としてもよい。このようにして形成された透明電極12と不透明電極14と挟まれた有機EL層13の領域に，前者を陽極，後者を陰極として電圧を印加すると，3つの発光ピークを持つ白色の発光ダイオードとして機能する。

一方，液晶表示装置20としては，画素への信号書き込み方式の違いによる様々な種類の反射型液晶表示装置を使用することができる。即ち，直交する短冊状電極により液晶分子の配向を制御する単純マトリクス型，絶縁材料を金属材料で挟んだダイオード素子により個別の画素電極に電圧を印加するMIM型，更に，ダイオードの代わりにアモルファスシリコン，多結晶シリコン等の材料をベースとした薄膜トランジスタ(TFT)により個別の画素電極に電圧を印加するTFT型の液晶表示装置のいずれでも良い。いずれの場合も，個別に電圧を制御できる液晶の領域である複数の画素が存在し，これらは規則正しく配列される。図1(b)においては，カラー表示が可能な反射型液晶表示装置の例を示している。即ち，この液晶表示装置20は，ガラス基板等の上に複数の反射部材22を規則正しく配列した電極基板21と，一様な透明電極27と個別のカラーフィルタ26を有する透明基板27とで，厚さ2μmから5μm程度の液晶24を挟んで構成される。このとき，透明基板27と電極基板21とは，カラーフィルタ26と反射部材22とが1対1に対応するようにお互いの位置が合わせられる。また，両方の基板の液晶に接する面には，液晶分子をある角度を持って配列させるために，配向膜23，25が形成されている。更に，透明基板27の液晶24へ対向しない側の表面へは，位相差板28と偏光板29が張り合わされる。反射部材22は，光を広い方向へ反射するための凹凸形状を持っており，個別に電圧を印加できるようになっている。このような反射部材は，例えば，フォトリソグラフィ法によりポリイミド等の材料に凹凸形状を形成し，その上にアルミニウム等の反射率が高い材料をスパッタ法により形成し，フォトリソグラフィ法により個別のパターンに分離して形成される。液晶表示装置の表示の単位である画素は，R，G，Bの3色のカラーフィルタを1セットにして構成される。これらの画素の配列ピッチが小さいと高精細の画像表示が可能になる。例えば，図２に示すように配列されたR,G,Bの各画素は約120μm×30μmの面積で，127μmのピッチで配列されるものとする。また，透明基板27の厚さは0.3mmから1mm程度である。

このとき，フロントライト10の不透明電極14は，液晶表示装置20の2画素分に相当する254μmのピッチのメッシュとなり，パターンの幅を10μmとすると，不透明電極の占有する面積比は(10/254)×(10/254)=0.00155となり，99.8%の開口率となる。

次に，図１から図4を参照しながら，この実施例の構成の動作について説明する。フロントライト10の透明電極12と不透明電極14との間に5V～15V程度の電圧を印加すると，両者によって挟まれた領域の有機EL層13から白色光が発せられる。特に発光素子の構造を工夫しない場合は，光は四方八方へ等方的に発せられる。ここで，図1，図4に模式的に示したように，液晶表示装置20の方向へ発せられた光はそのまま，また，不透明電極14の方向へ発せられた光は一度それによって反射された後に液晶表示装置20を照明する。光は液晶表示装置20の透明電極27，カラーフィルタ26，等を順に透過し，カラーフィルタにより選択された波長の光の成分のみが反射部材22へ到達する。

ここで，反射部材22の面が一様に照明されるか否かは，不透明電極14（即ち発光部）と反射部材22との位置関係で決まる。発光部の配列ピッチが大きくなればなるほど，反射部材の存在する面での照度分布が不均一になる。一方で，この配列ピッチを小さくすれば，不透明電極が占有する面積が大きくなる。このとき，フロントライトを使用しない場合に周囲から入射する光が反射部材に到達する確率が低くなり，その結果，表示が暗くなる。このように，周囲光の利用効率と，フロントライトの光による照度分布とを勘案して，不透明電極と反射部材との位置関係を決定する必要がある。図2において，メッシュ状の不透明電極（即ち発光部）と反射部材（及びカラーフィルタ）との位置関係が，メッシュの一枡に4画素が対応するように形成されているのは，このような事情によるものである。また，フロントライト10の発光部から液晶表示装置の反射部材22までの距離は0.6mm以上あり，前述のように光の指向性は強くないために，反射部材22は一様に照明されることになる。当然，目標とする周囲光の利用効率，フロントライトの光量，等は，表示装置が使用される環境に依存するので，本発明の趣旨は，このような数値例に制限されるものではない。

反射部材22に達した光は，液晶24，カラーフィルタ26等を逆の順に透過し，更に，フロントライト10の不透明電極14で占有されていない領域を透過した後に，不図示の観察者に至る。ここで，液晶24に印加される電圧により透過する光量を制御できるので，任意の画像の表示が可能となる。

以上に説明したように，本発明の液晶表示装置の構成では，フロントライトが発光部と透明部とを規則正しく配列した面状光源であるため，補助光源としてフロントライトを使用するときも使用しないときも，高い表示性能を維持できる。即ち，フロントライトを補助光源として使用するときには，液晶表示装置の全表示領域に渡って均一に照明することができる。また，外光の進路を変えるようなため特別な仕組みが存在しないので，従来のフロントライトを備える反射形液晶装置の場合に課題となった，周囲の外光の散乱，表面にゴミや油等の異物が付着した場合の表示性能劣化，といった課題を解決することができる。更に，フロントライトから発せられた光の殆どが液晶表示装置の照明に用いられ，殆ど全ての反射光が観察者へ到達するので，フロントライトを利用する場合の光の利用効率が高いという利点がある。

以上の説明では，不透明電極14を単一の材料としたが，例えばアルミニウムの表面を陽極酸化して黒色の顔料をメッキするなどの工程により，有機EL材料13に接しない側の表面に光を吸収する性質を持たせることも可能である。このような場合には，周囲からフロントライトへ入射する光の中で，フロントライトを透過しない成分は不透明電極により吸収される。従って，不透明電極による反射により液晶表示装置のコントラストが低減することを防止し，高いコントラストを得ることができる。

以上の説明では，フロントライトの構成において，端子部を除けば不透明電極のみがメッシュ状にパターン化されて形成される例を挙げたが，本発明はこれらの構成要素の形状に制限を加えるものではない。即ち，フロントライトの構成要素である有機EL層と透明電極とパターン化しても同様の効果が得られる。図5，図6，図7は，そのようなフロントライトの変形実施の形態を示す模式断面図である。これらの図において，図1(b)に示した実施例と同じ構成要素には同じ番号を付している。図5のフロントライト10bでは，有機El層14bがパターン化されて不透明電極14bの下部に存在する。図6のフロントライト10cでは，透明電極12cがパターン化されて不透明電極14cの下部に存在する。図7のフロントライト10dでは，透明電極12dと有機El層14dとが共にパターン化されて不透明電極14dの下部に存在する。これらの動作と効果は，図1の実施例と同じである。但し，図7の実施例では，有機EL層13dの膜厚方向の側面にも不透明電極14dで覆われるので，この方向へ逃げる光が遮蔽される点が他の実施例と異なる。また，図5から図7に示した変形実施例では，フロントライトの電極材料をフォトリソグラフィ法によりパターン化する工程が余分に必要になる。この工程の増加は製造コストの増加につながるという不利な面もあるが，図6と図7においては，端子部での透明電極との重なりを除去することにより，フロントライトの光の利用効率を向上できるという利点もある。一方，図4の構成では，不透明電極14をパターン化して形成した端子部の下部にも有機EL層13と透明電極12とが存在するため，この領域からも発光する。しかし，端子部は液晶表示装置10の反射部材22が存在しない領域に形成されるので，端子部から発せられた光が表示に利用されることは無い。当山，この光を液晶表示以外の表示，或いは外部の照明の目的で利用することは可能である。

また，以上では，フロントライトのメッシュ状の発光領域が液晶表示装置の反射部材に整列して配置される例を挙げて説明した。本実施例の変形実施の形態として，図8に示すように，フロントライト10eのメッシュ状の不透明電極を，液晶表示装置20の反射部材に対して45度回転して配置した構成としても良い。この目的は，図2のパターンを上から観察するときに，視線の角度により，不透明電極が例えばRの画素列の一部に重なる割合に応じて，赤色の輝度が減少して見えるのを防止することである。従って，両者の角度は45度に限るわけではない。但し，この角度や不透明電極の配列ピッチ等の選び方によっては，次に説明するモアレ縞が発生して，液晶表示装置の表示性能を劣化させることがあるので注意を要する。

一般に，一つの周期を持つパターンを別の周期を持つパターンに重畳するときに，それら2つの周期から決まる規則的なパターン(モアレ縞)が発生する。従来の構成のフロントライトを液晶表示装置に重ね合わせる場合にも，導光体に設けた規則パターンと液晶表示装置の構成要素の規則パターンにより，このようなモアレ縞が発生することがある。先に引用した従来の技術を示す公開特許公報においては，モアレ縞が実際に観察者の気にならないレベルになるような構成要素の条件を実験により決定している。即ち，具体的には，導光体に設ける1次元パターンと液晶表示装置の画素配列とが22.5度乃至25度の角度を持つようにすると良いとしている。これらの数値はある特定の実験条件に特有のもので，何ら普遍性があるわけではない。例えば，観察者の視力，周囲の明るさ，等の実験条件に依存するものである。一方，2つの異なる周期を持つパターンを重ねたときにモアレ縞を発生させないためには，一方の空間周波数が他方の空間周波数の整数倍であれば良いことが知られている。図2に示した構成はこの条件を満たすため，即ち一方が他方の2倍に設定されているので，モアレ縞が発生することは無い。メッシュパターンを45度傾けると，液晶表示装置の規則パターンの方向へ投影したメッシュパターンの空間周波数スペクトラムは先鋭なピークを持たず，その結果，モアレ縞は実用上目立たなくなる。

更に，以上ではフロントライトの不透明電極の形状をメッシュ状として説明したが，当然，この形状はメッシュに限るものではない。例えば，図9に示すライン状のパターンや，図10に示す蛇行したパターンを用いても同様の効果が得られる。

また，以上の説明では，カラーフィルタを有する反射型液晶表示装置を挙げて説明したが，カラーフィルタを有さないモノクロの反射型液晶表示装置にも本発明を適用することができる。更に，フロントライトとして透明基板側に光を発する構成を例に挙げたが，透明電極と不透明電極とを入れ替えて，透明基板と反対側に光を発する構成としてもよい。このように，本発明の趣旨を損なうことなく，様々な構成要素の置換が可能であり，そのような構成についても，本発明の第一の実施例の変形実施の形態と見なすことができる。

(本発明の構成の第二の実施の形態)

本発明の第二の実施の形態においては，フロントライトの電極を分割した構成を用いる。図10はそのようなフロントライトの電極の構成を示す説明図である。図10においては，フロントライトの不透明電極が3つに分割されて，独立してこれらの電圧を設定できるように構成されている点が第一の実施の形態と異なる。3つの互いに平行して配置された電極に独立に一定の電圧を加えることにより，図10のような電極の形状では，フロントライトの輝度を3段階に設定できる。これはフロントライトの輝度を簡単な駆動回路で制御できるという利点がある。第一の実施例の構成を用いても，有機EL層に印加する電圧値を調整することによりフロントライトの輝度を制御できるが，そのためには，有機EL素子の印加電圧と光出力の特性

を正確に把握し，電圧を精度良く印加する必要がある。図10の構成では，3つのデジタル信号により，例えば5Vの電圧を3つの電極のどれかに印加する組み合せである8通りの輝度を実現できる。このようなデジタル駆動により，高度なアンプ回路は不要となる。当然，電極数を増加させれば，より制度の高い輝度制御が可能になる。

以上では，複数に分割するフロントライトの電極の例として不透明電極を用いる例を挙げて説明したが，透明電極を複数に分割しても同様の効果が得られる。従って，このような構成も本発明の第二の実施例の変形実施と見なす。

（本発明の構成の第三の実施の形態）

第二の実施の形態においては，フロントライトの分割された複数の電極の全てが液晶表示装置の表示領域のほぼ全域を覆う構成としたが，例えば，図11に示すように，2つに分割されたフロントライトの不透明電極が，それぞれ分離された液晶表示装置の表示領域を覆う構成としても良い。このような構成においては，液晶表示装置の特定の領域のみを分割して照明することが可能であるという利点を持つ。そのような表示例としては，携帯電話のパーシャル表示の機能がある。

以上では，複数に分割するフロントライトの電極の例として不透明電極を用いる例を挙げて説明したが，透明電極を複数に分割しても同様の効果が得られる。従って，このような構成も本発明の第三の実施例の変形実施と見なす。

【発明の効果】

本発明の効果を実施例に基づいて説明する。

全ての実施例に共通して，以下に述べる効果がある。即ち，本発明によると，効率良く均一に液晶表示装置を照明することができるので，良好な表示性能を得ることができる。また，フロントライトの表面に異物が付着しても表示性能に大きな影響を与えることはない。更に，従来の導光体を用いたフロントライトに比べて部品点数が少なく，製造コストを削減できる。

第二の実施の形態については，前述の効果に加えて，フロントライトの輝度を簡単な駆動回路で制御できるという効果がある。

第三の実施の形態については，第一の実施例の効果に加えて，パーシャル表示機能を備えた反射型液晶表示装置を低コストで実現することができるという効果がある。

【図面の簡単な説明】

【図1】

第一の実施の形態におけるフロントライトを用いた液晶表示装置の概略構成を示す説明図である。

【図2】

上記液晶表示装置が備えるフロントライトの不透明電極と，液晶表示装置が備えるカラーフィルターとの位置関係を示す説明図である。

【図3】

上記液晶表示装置が備えるフロントライトの不透明電極の形状を示す説明図である。

【図4】

上記液晶表示装置が備えるフロントライトの一部の概略構成と該フロントライトの動作を示す斜視図である。

【図5】

上記液晶表示装置が備えるフロントライトの変形実施の形態を示す模式断面図である。

【図6】

上記液晶表示装置が備えるフロントライトの変形実施の形態を示す模式断面図である。

【図7】

上記液晶表示装置が備えるフロントライトの変形実施の形態を示す模式断面図である。

【図8】

上記液晶表示装置の変形実施の形態を示す説明図である。

【図9】

上記液晶表示装置が備えるフロントライトの不透明電極の変形実施の形態を示す説明図である。

【図10】

第二の実施の形態におけるフロントライトを用いた液晶表示装置において，上記フロントライトの不透明電極の形態を示す説明図である。

【図11】

第三の実施の形態におけるフロントライトを用いた液晶表示装置において，上記フロントライトの不透明電極の形態を示す説明図である。

【図12】

従来のフロントライトを用いた液晶表示装置の実施の形態を示す模式断面図である。

【符号の説明】

10. フロントライト

11. 透明基板

12. 透明電極

13. 有機EL層

14. 不透明電極

15. 保護層

20. 液晶表示装置

21. 電極基板

22. 反射部材

23. 配向膜

24. 液晶

25. 配向膜

26. カラーフィルター

27. 透明基板

28. 位相差板

29. 偏光板

30. カラー分離用回折格子

110. フロントライト

111. 線状光源

112. 導光体

112a. 入射面

112b. 反射面

112c. 出射面

113. 保護部材

120. 液晶表示装置

121. 電極基板

122. 反射部材

123. 液晶

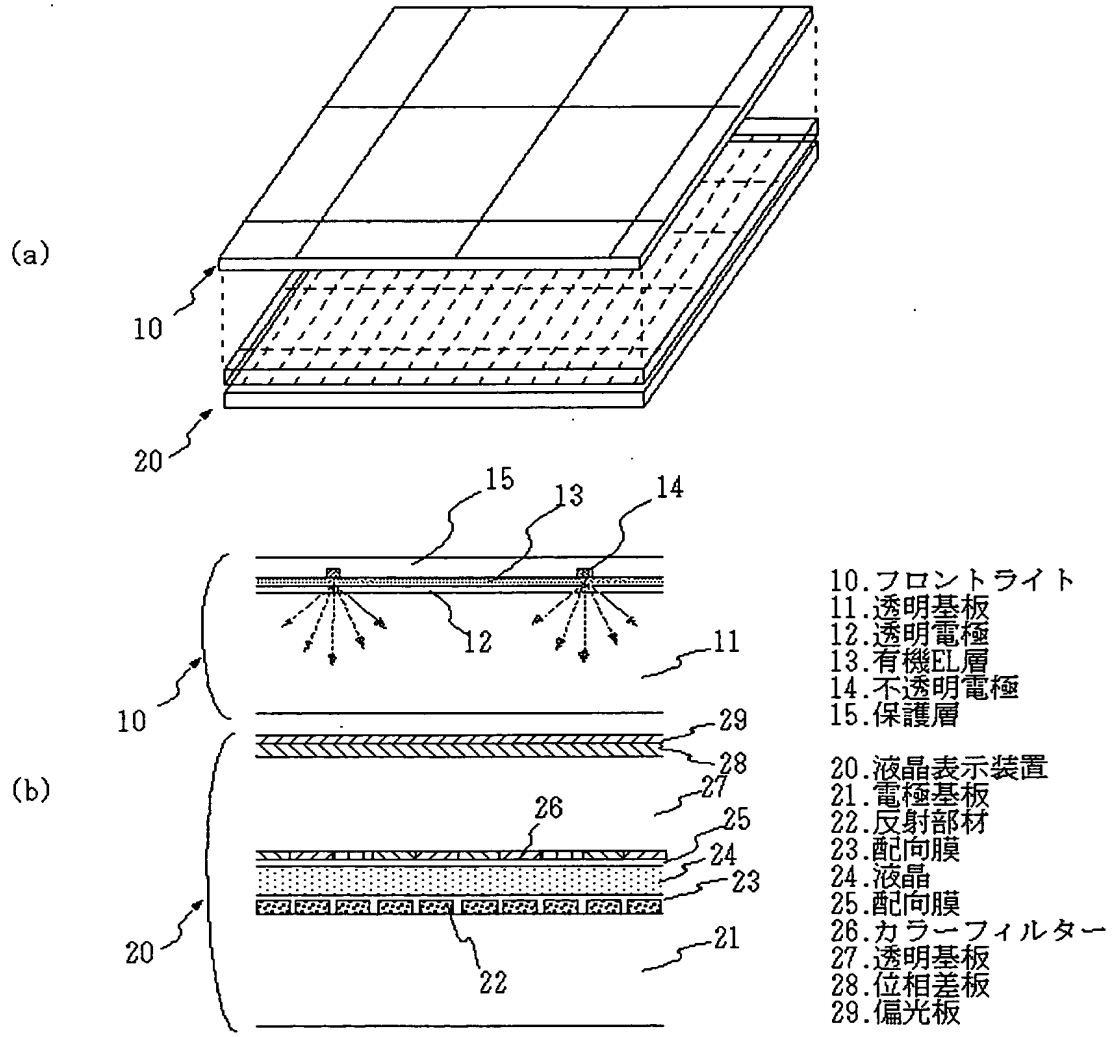
124. 透明基板

125. 位相差板

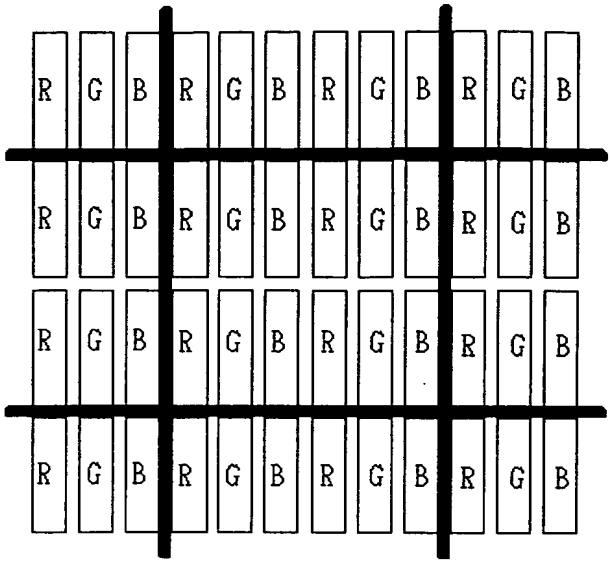
126. 偏光板

【書類名】図面

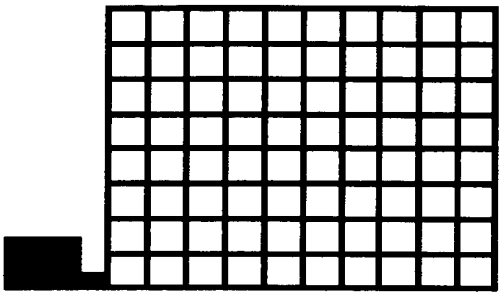
【図1】



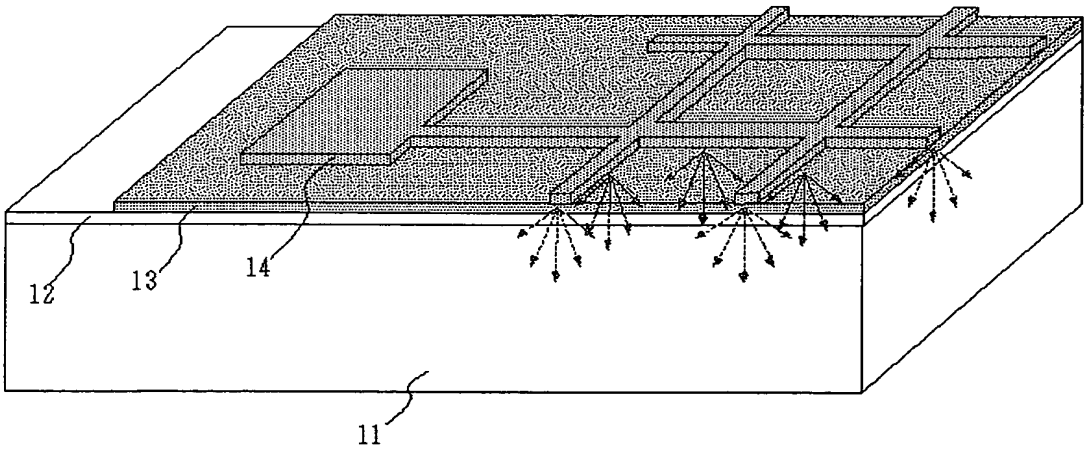
【図2】


R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B

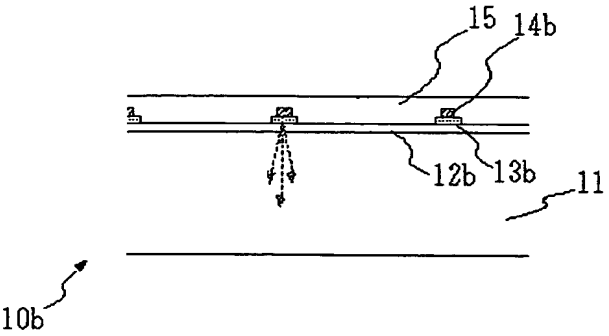
【図3】



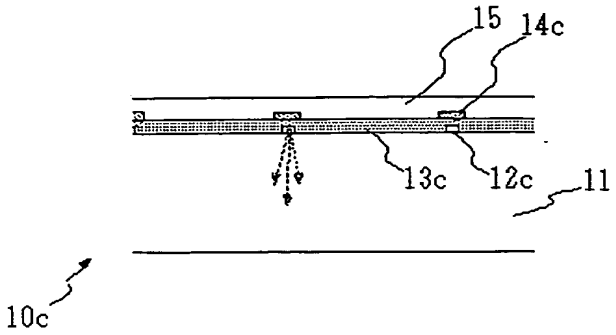
【図4】


12
13
14
11

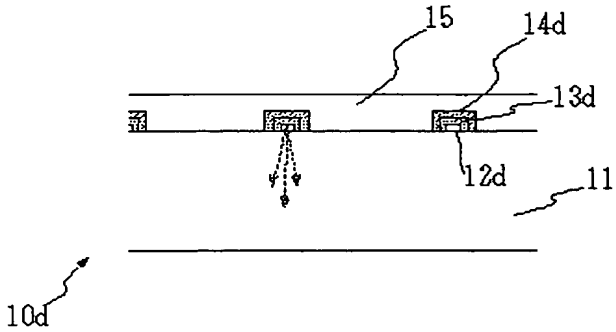
【図5】


15
14b
12b
13b
11
10b

【図6】

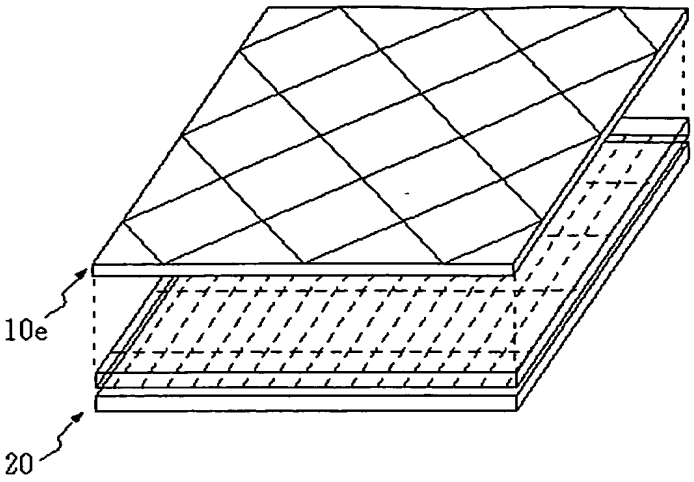


【図7】

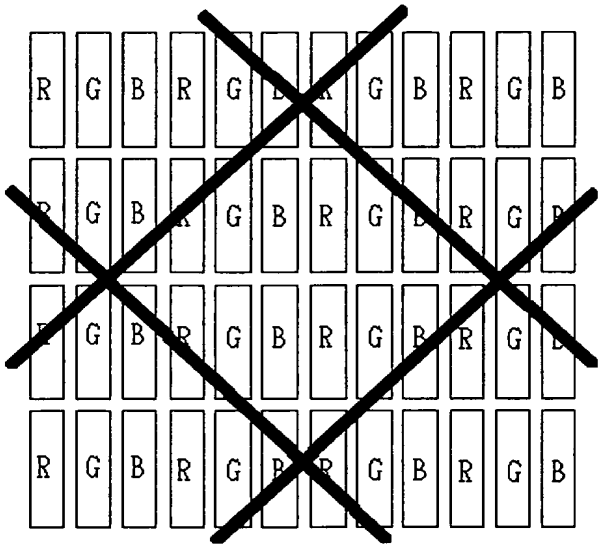


【図8】

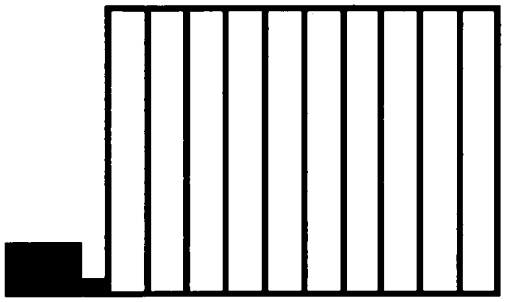
(a)


10e
20

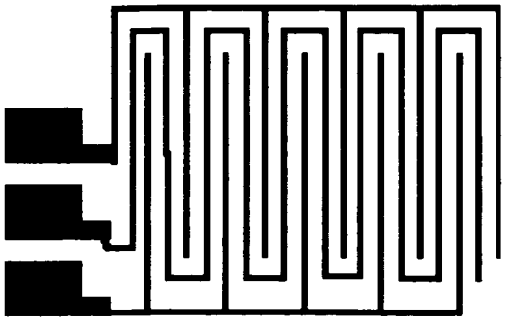
(b)


R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B

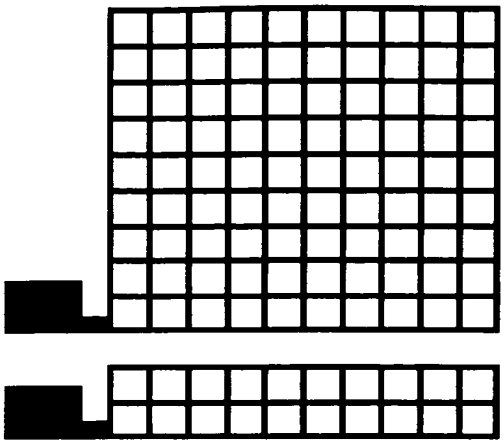
【図9】



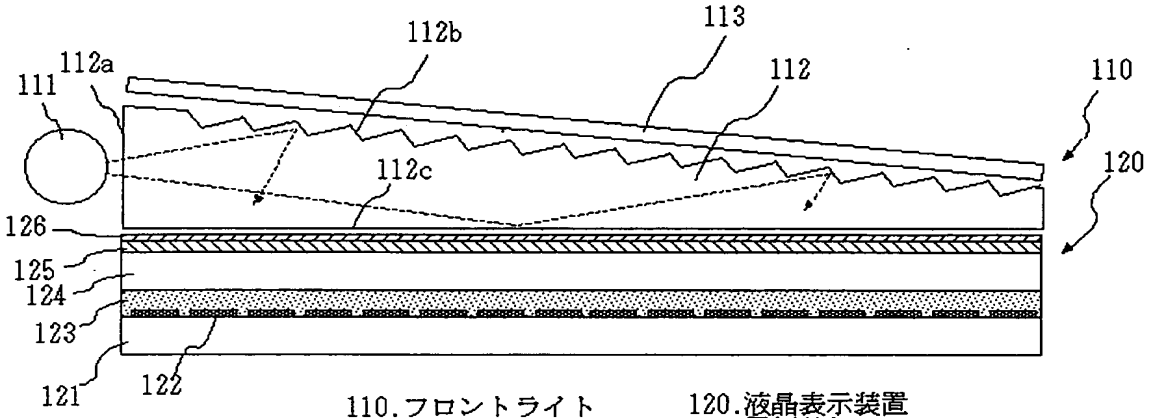
【図10】



【図11】



【図12】



110.フロントライト
111.線状光源
112.導光体
112a.入射面
112b.反射面
112c.出射面
113.保護部材
120.液晶表示装置
121.電極基板
122.反射部材
123.液晶
124.透明基板
125.位相差板
126.偏光板

【書類名】　要約書

【要約】

【課題】

導光体の端部に光源を配置した構成の従来のフロントライトでは，効率良く均一に反射型液晶表示装置を照明するのは困難で，また，導光体の表面に異物が付着すれば表示性能が大きく劣化するという課題がある。また，パーシャル表示機能を備えた反射型液晶表示装置を低コストで実現することは困難である。

【解決手段】

液晶表示装置の前方に配置されて，上記液晶表示装置の方向へ光を発する照明手段が，複数の光を発する領域と，複数の光を透過する領域とを有する。上記照明手段の光を発する領域の液晶表示装置へ対向しない側の表面は，光を吸収する性質を持つ。液晶表示装置の複数の反射手段が第一の配列間隔で配置され，上記照明手段の複数の発光領域が第二の配列間隔で配置され，上記第二の配列間隔は上記第一の配列間隔の整数倍である。液晶表示装置の複数の反射手段の配列方向と，上記照明手段の複数の発光領域の配列方向とが，互いに0でない角度を成す。上記照明手段の複数の発光領域を2つ以上の複数のグループとして独立に制御する手段を有する。

【選択図】　図1

- TRANSLATION -

EMPLOYEE'S INVENTION REPORT・ASSIGNMENT・OPINION (NEC INDEPENDENT APPLICATION)

【INVENTORS COLUMNS FOR ENTRY】

February 14, 2000
Temporary No 11135819 Title of the Invention : Front Light and Liquid Crystal Display Device
Reference No 348-03411

	Confirm.	Employee Number	Name	INVENTORS Internal Tel. External Tel.	e-mail address Company,Division Fax, No.
1	Done	0000 874082	Ichiro Fujieda	272-3070 044-856-8138	fujieda@ddl.cl.nec.co.jp 044-856-2097 NEC Corp. Functional Device Lab. Display Device Lab.

Type of Disclosure	○	By Description of Invention (Embodiments, drawings)
	●	By complete specification
	○	By concurrent processing
Request for Oversea Appl	●	Requested — Requested country: US, KR, TW
	○	Not requested
Request for national priority	○	Voluntary — No. of prior application:
	○	Requested by IP Group — Date of prior application: (y.m.d.)
	●	Not requested — Reference No. of prior application:
		Date of request by IP Group: (y.m.d.)
Scheduled date of disclosure	○	Product release — Name of Product:
	○	By thesis — Name of Society:
	○	Newspaper — Date of publicatio:
	○	Other
	●	No Disclosure outside NEC
	☐	Product Delivery — Destination of Delivery:
		Date of Delivery: (y.m.d.)
Related Invention (Please enter, if any)		No. of Application
		Filing Date: (y.m.d.)
		Reference No.
		Name of Countries, if filed.
Type of Inven	○	Business Model Invention
	●	Other Inventions

Assignment:

Concerning the above invention, I will assign the right of receiving Patent or Utility Model thereof based on NEC Corporation Employee Rules.

【OPINION BY THE MANAGER CONCERNED】

February 14, 2000

Right belongs to: Inventive activities related to present or past duties: ● Yes ○ No

Related Project: Name of Project:
- ○ Key Development Project
- ○ Other than Key Development Project
- ● Not Applicable

Relationship with a specific customer: ☐ S.D.F. ☐ JR ☐ NTT ☐ MITI ☐ NP (National Project)

EXHIBIT "C"

EVALUATION OF THE INVENTION

1 Possibility for Allowance:
○ 80% or more ●60–80% ○ 30–60% ○ 30% or less ○ None

2 Nature of Idea:
☐ New technical concept
☐ Taking a new technology in advance
■ Provide a superior alternative
☐ Desired to realize this idea
☐ Provide a new function

3 Fundamental/Improvement:
○ Totally Fundamental Invention
● Total Improvement Invention
○ Possibly, fundaemental invention
○ Partial Improvement Invention

4 Technical Impact:
○ Very large ● Large ○ Normal ○ Small

5 Implementation: (Including external NEC)
○ Implementation decided
Delivery y.m.d.:
● Implement in 5 years
○ Trial in progress
Delivery y.m.d.:
○ Unknown

6 Generality (Possibilty of application to other technical field)
○ High ●Middle ○ Low

7 Life of Technology
● Long ○ Middle ○ Less than 3 years

8 Possibility of evasion:
○ Impossible ● Considerably hard ○ Probable ○ Easy

9 Infringement Search:
● Easy ○ Considerably hard ○ Very hard

Total Evaluation: ● A ○ B1 ○ B2

Overseas Application: ● Yes ○ No

A. Countries Requested for Filing:

■ America	US (1)
☐ Korea	KR ( )
☐ China	CN ( )
☐ Taiwan	TW ( )
☐ England	GB ( )
☐ Germany	DE ( )
☐ France	FR ( )
☐ Italy	IT ( )
☐ Sweden	SE ( )
☐ Holland	NL ( )
☐ Canada	CA ( )
☐ Australia	AU ( )
☐ Singapore	SG ( )
☐ Malaysia	MY ( )
☐ Thailand	TH ( )
☐ Phillipines	PH ( )
☐ Indonasia	ID ( )

B. Reasons:

1. Possible to export a product having the invention implemented .
2. Possible to manufacture a product having the invention implemented in overseas sites.
3. Possible to export technology having the invention implemented.
4. Licensee of a product being licensed to NEC is still active in business
(Please enter the name of licensee in parenthesis.)
5. Give names of competitors of a product having the invention implemented.
(Please enter the name of competitor in parenthesis.)
6. Other reasons, if any.

Decision made by Manager concerned: Application: This invention is considered to be pantentable so that I request the filing of this application.

● Application approved
○ Cancel for combination
○ Disclosure in technical publication
○ Cancel for other than combination

Approved by Manager Concerned: Emplyee No.: 0498644 Name: Hiroshi Hayama

[RESPONSIBLE PERSON FOR SELECTION COLUMNS]

February 14, 2000

Responsible person for selection:

- ○ Selected as S class
- ● Application approved
- ○ Disclosure in technical publication
- ○ Cancel for combination
- ○ Cancel for other than combination

Selected by: Emplyee No.: 0498644 Name: Hiroshi Hayama

Remarks: Requests for IP Group:

[Document] Specification
[Title of the Invention]
LIQUID CRYSTAL DISPLAY DEVICE
[What is Claimed is:]
[Claim 1] A liquid crystal display device comprising:
a liquid crystal display device having a plurality of reflection means; and
illumination means which is disposed in front of a display surface of the liquid crystal display device and which emits light in the direction toward the plurality of reflection means, wherein the device characterized in that the illumination means has a plurality of light-emitting area, and a plurality of light-transmitting area.
[Claim 2] The liquid crystal display device according to claim 1, characterized in that a surface of the light-emitting area of the illumination means on the side that does not face the liquid crystal display device has light absorbing characteristics.
[Claim 3] The liquid crystal display device according to claim 1 or 2, characterized in that the plurality of reflection means of the liquid crystal display device are arranged in a first arrangement pitch, a plurality of the light-emitting areas of the illumination means and a plurality of the light-transmitting areas are arranged in a second arrangement pitch, and the second arrangement pitch is an integral multiple of the first arrangement pitch.
[Claim 4] The liquid crystal display device according to claim 1, characterized in that an angle between arrangement direction of the plurality of reflection means of the liquid crystal display device and that of the plurality of light-emitting areas of the illumination means is set at any degree other than 0.
[Claim 5] The liquid crystal display device according to any of claims 1 to 4, characterized by comprising means for individually controlling two or more grouped light-emitting areas of the illumination means.
[Claim 6] The liquid crystal display device according to any of claims 1 to 5, characterized in that the illumination means includes a transparent electrode, organic EL material, and opaque electrode which are stacked on a transparent substrate.
[Claim 7] A method for manufacturing the liquid crystal display device characterized by:
the step of forming said transparent electrode on said transparent substrate, the step for forming said organic EL material, and the step for forming the patterned opaque electrode overlying said organic EL material.
[Detailed Description of the Invention]
[Technical Field of the Invention]
The present invention relates to a liquid crystal display device mounted in a device, such as a mobile phone or personal digital assistance like a notebook computer, and more particularly, to a reflective-type liquid crystal display device using a front light as an auxiliary light source.
[Prior Art]
Reflective-type liquid crystal display devicees using a front light have been disclosed in Jpn. Pat. Appln. Laid-Open Publication No. 2000-29008, Jpn. Pat. Appln. Laid-Open Publication No. 2000-19330, Jpn. Pat. Appln. Laid-Open Publication No. 11-326903, and the like. Of these, the reflective-type liquid crystal display device using a front light disclosed in Jpn. Pat. Appln. Laid-Open Publication No. 2000-29008 is taken as an example, and will be explained below.
A conventional reflective-type liquid crystal display device using a front light comprises a liquid crystal display device 120 including a reflective electrode 122 and the like, and a front light 110. As shown in FIG. 12, the front light 110 is disposed on the

liquid crystal display device 120. The front light 110 comprises a linear light source 111 which is constituted by linearly arranging a cold-cathode tube, light-emitting diode (LED), or the like, and which is disposed at an end portion of a light guiding member 112. Further, in this example, the side surface of the light guiding member 112 that does not face the liquid crystal display device 120 is processed in a staircase pattern, and a protection member 113 is disposed on the light guiding member 112.

Here is the operation of the device configured as above. The light emitted from the light source 111 enters inside of the light guiding member 112 through a side surface 112a thereof. The light is then reflected by a reflective surface 112b, so that the direction of progress of the light is changed. Thereafter the light is emitted from an emission surface 112c and enters the liquid crystal display device 120. The light that enters the liquid crystal display device 120 then transmits through a polarizing plate 124, retardation film 125, transparent substrate 124, and liquid crystal 123 in the mentioned order. Finally, the light is reflected by reflective members 122, transmits through the above-mentioned members in reverse order, and is emitted from the liquid crystal display device 120.

Amount of the emitted light is controlled by arrangement direction of liquid crystal molecules existed in an upper portion of the reflective members 122. Therefore, an individual control of the respective reflective members can adjust the voltage to be applied to the liquid crystal, which allows arbitrary patterns to be displayed. The light emitted from the liquid crystal display device 120, after transmitting through the front light 110, reaches an observer (not shown). In the configuration shown in FIG. 12, the protection member 113 prevents the reflective surface 112b from being damaged.

[Objects of the Invention]

The conventional reflective-type liquid crystal display device using a front light is configured as follows. The light emitted from the light source, which is disposed at an end portion of the light guiding member, propagates through inside of the light guiding member. Then the traveling direction of the light is changed at the surface of the light guiding member, and finally the light illuminates the reflective-type liquid crystal display device. Here, designing a mechanism (e.g., processing the surface into a step-like or prism shape) for taking the light out of the light guiding member is very important. However, it is difficult to uniformly illuminate the entire display area of the liquid crystal display device.

In addition, when an image is displayed by reflecting surrounding outside light, the mechanism described above also changes a traveling direction of the outside light. It follows that display capability may deteriorate when the front light is not used as an auxiliary light source. Further, when a foreign matter such as dust, oil, or the like is adhered to a surface of the light guiding member of the front light, light is further dispersed in that portion, which makes it difficult to obtain an uniform illumination. The light emitted from the light source leaks from the side surface of the light guiding member that does not face the liquid crystal display device. Therefore, the light utilization efficiency is low.

Some liquid crystal display devices have a function (hereinafter, referred to as "partial display") of displaying information such as time, condition of communication environment, or the like using only a part of display area, as popularized in the display function of, for example, a mobile phone. However, a

conventional front light cannot select for illumination only the area to be displayed.

The present invention has been contrived in view of the above situation, and an object thereof is to realize, at a low cost, a reflective-type liquid crystal display device comprising a front light, which can efficiently and uniformly illuminate a liquid crystal display device and whose display capability is not adversely affected even if a foreign matter is adhered to a surface of the front light.

Another object of the present invention is to realize a reflective-type liquid crystal display device having a partial display function at a low cost.

[Means for Achieving the Objects]

According to the liquid crystal display device as defined in claim 1 of the present invention characterized by:

A liquid crystal display device comprising:

a liquid crystal display device having a plurality of reflection means; and

illumination means which is disposed in front of a display surface of the liquid crystal display device and which emits light in the direction toward the plurality of reflection means, the device characterized in that the illumination means has a light-emitting area including a material capable of emitting light when being supplied with a current, and light-transmitting area.

According to the liquid crystal display device as defined in claim 2 of the present invention characterized in that a surface of the light-emitting area of the illumination means on the side that does not face the liquid crystal display device has light absorbing characteristics.

According to the liquid crystal display device as defined in claim 3 of the present invention characterized in that the plurality of reflection means of the liquid crystal display device are arranged in a first arrangement pitch, a plurality of the light-emitting areas of the illumination means and a plurality of the light-transmitting areas are arranged in a second arrangement pitch, and the second arrangement pitch is an integral multiple of the first arrangement pitch.

According to the liquid crystal display device as defined in claim 4 of the present invention characterized in that an angle between arrangement direction of the plurality of reflection means of the liquid crystal display device and that of the plurality of light-emitting areas of the illumination means is set at any degree other than 0.

According to the liquid crystal display device as defined in claim 5 of the present invention characterized by comprising means for individually controlling two or more grouped light-emitting areas of the illumination means.

According to the liquid crystal display device as defined in claim 6 of the present invention characterized in that the illumination means includes a transparent electrode, organic EL material, and opaque electrode which are stacked on a transparent substrate.

According to the liquid crystal display device as defined in

claim 7 of the present invention characterized in that the illumination means has a structure in which the transparent electrode is formed on the transparent substrate, the organic EL material is formed on the transparent electrode, and the patterned opaque electrode is formed on the organic EL material.

[Embodiments]

[First embodiment of the present invention]

Embodiments of the present invention will be described below with reference to the accompanying drawings. FIGS. 1 (a) and 1 (b) are explanatory views schematically showing main components of a liquid crystal display device and their arrangements in a first embodiment of the present invention. The liquid crystal display device according to the present invention comprises a liquid crystal display device 20 and a front light 10 disposed above the device 20, as shown in FIG. 1 (a). As shown in the cross-sectional view of FIG. 1 (b), the front light 10 is formed by stacking, on a transparent substrate 11, a transparent electrode 12, electro-luminescence (EL) layer 13, which is made of an organic material, and opaque electrode 14 in this order. A protection layer 15 is provided on a surface of the front light 10.

In the liquid crystal display device 20, a transparent substrate 21 including a plurality of reflective members 22 and an orientation film 23, and a transparent substrate 27 including a color filter 26 and an orientation film 25 sandwich a liquid crystal 24. FIG. 2 is an explanatory view showing positional relationship between the opaque electrode 14 of the front light 10 and the color filter 26 of the liquid crystal display device 20. As shown in FIG. 3, the opaque electrode 14 of the front light 10 has a mesh-like shape, and has a connection terminal for applying voltage. FIG. 2 shows that one grid of the opaque electrode 14 of the front light 10 corresponds to four pixels of the liquid crystal display device 20. As schematically shown in FIG. 2, the ratio of area that the opaque electrode 14 occupies should be extremely small.

FIG. 4 is an explanatory view showing a configuration in the vicinity of the terminal for applying voltage to two electrodes (opaque electrode 14 and transparent electrode 12) of the front light 10. As shown in FIG. 4, the transparent electrode 12 is uniformly formed on a surface of the transparent substrate 11, and a substantially entire surface thereof except the portion where the terminal is disposed is covered by the organic EL layer 13, which is an insulating layer. The opaque electrode 14 formed on the organic EL layer 13 is not in contact with the transparent electrode 12. The front light 10 and liquid crystal display device 20 may be retained with an air layer interposed therebetween, and may be fixed using an optical adhesive whose refraction index is substantially the same as that of the transparent substrate.

Hereinafter, the embodiment of the present invention will be described in detail with a material, manufacturing method, and numeric value taken as concrete examples. A glass, plastic substrate, film substrate or the like that has a thickness in the range of 0.3 to 1 mm is used for the transparent substrate 11 of the front light 10. As for the transparent electrode 11, an indium tin oxide (ITO) film or the like is formed on the entire surface of the transparent substrate 11 by a sputtering method. In the case where ITO is used as a material of the transparent electrode 11, sheet resistance should be about 20/□, and thickness thereof about 100 nm. As for the organic EL layer 13, two-layer structure including a light-emitting layer and hole injection transporting layer, three-layer structure

including an electron injection transporting layer in addition to the above two layers, and a structure in which a thin insulating film is disposed to an interface with a metal electrode are known. Any of these structures can be applied to the liquid crystal display device shown in FIG. 1 (b).

That is, the relevant layer is referred to as organic EL layer 13 in FIG. 1 (a), but a close look confirms that various structures described above can be available. As for a method for manufacturing the organic EL layer 13, a spin coating method, vacuum deposition method, ink-jet printing method and the like are known. Corresponding to the manufacturing methods, manufacturing conditions such as a selection of the organic EL material of high molecular type, low molecular type or the like, a substrate structure, or a manufacturing method of an upper electrode are determined.

In this embodiment, the organic EL layer 13 includes the hole injection transporting layer and light-emitting layer. As the hole injection transporting layer, for example, triarylamine derivative, oxadiazole derivative, porphyrin derivative, and the like are used. As the light-emitting layer, for example, metal complex of 8-hydroxyquinoline and derivative thereof, tetraphenylbutadiene derivative, distyrylaryl derivative, and the like are used. These materials described above are stacked together by vacuum deposition method to form the organic EL layer with the hole injection transporting layer and light-emitting layer each having thickness of about 50 nm. In this case, a metallic shadow mask is used to prevent the organic EL materials from being deposited on the terminal area of the transparent electrode 12 shown in FIG. 4. Note that desired wavelength of light can be selected through a choice of the materials. In this example, materials of the organic EL layer 13 are selected so that the organic EL layer 13 has three-color components having a peak at a wavelength of 450 nm, 540 nm, and 630 nm each of which corresponds to the light's three primary colors.

The opaque electrode 14 is formed by, for example, vacuum depositing a material such as aluminum-lithium alloy on the organic EL layer 13 through the metallic shadow mask to a thickness of about 200 nm. In order to protect the organic EL layer 13 from oxygen or moisture, the protection layer 15 made of metal oxide, metal sulfide or the like is provided on the entire surface of the front light 10. In place of the protection layer 15, a plastic cover can be used to cover the entire device to act as a seal layer by replacing air with inactive gas such as nitrogen, argon or the like.

Applying voltage to the region formed as described above which includes the transparent electrode 12, the opaque electrode 14, and the organic EL layer 13 sandwiched by them allows the region to act as a white light-emitting diode having three emission peaks. In this case, the voltage is applied with the transparent electrode 12 being an anode, and the opaque electrode 14 being a cathode.

As for the liquid crystal display device 20, different kinds of reflective-type liquid crystal display devices having various kinds of method for writing signals into pixels can be used. Specifically, any of the display devices of a simple matrix type which controls orientations of liquid crystal molecules by means of orthogonal-strip electrodes, MIM (Metal-Insulator-Metal) type which applies voltage to individual pixel electrodes by means of a diode device formed by sandwiching an insulating material by metal, and TFT type which applies voltage to individual pixel electrodes by means of thin film transistor (TFT) made based on amorphous silicon, polycrystalline silicon, and the like without using a diode may be used. In either case, a plurality of pixels are included in the liquid crystal area where voltage to be applied can individually be controlled, and are

arranged with regularity.

FIG. 1 (b) shows an example of a reflective-type liquid crystal display device capable of color display. The liquid crystal display device 20 of FIG. 1 (b) comprises an electrode substrate 21 formed by arranging a plurality of reflective members 22 with regularity on a glass substrate or the like, a transparent substrate 27 including a uniformly formed transparent electrode 27 and individualized color filter 26, and a liquid crystal 24 having a thickness of about 2 μm to 5 μm disposed between the electrode substrate 21 and the transparent substrate 27. The transparent substrate 27 and the electrode substrate 21 are positioned such that the color filter 26 and the reflective members 22 have one to one relation with each other. Further, orientation films 23, 25 are formed on the surfaces of the both substrates that contact the liquid crystal in order to arrange the liquid crystal molecules at a specific angle.

A retardation film 28 and polarizing plate 29 are bonded in this order to the surface of the transparent substrate 27 on the side that does not face the liquid crystal 24. The reflective members 22 have a concave and convex shape for reflecting light widely, and voltage can be applied individually to reflective members. The reflective members configured as above are formed in the manufacturing step as follows: forming a concave and convex shape on a material such as polyimide or the like by photolithography; forming a material having high reflectance such as aluminum or the like on the concave and convex shape by sputtering; and individual patterns are obtained by photolithography. A pixel, which is a unit of display in a liquid crystal display device, is constituted by three color filters R, G, and B as one set.

As an arrangement pitch of pixels becomes small, a high resolution image can be displayed. For example, assume that each of the pixels, R, G, and B arranged as shown in FIG. 2 have a size of about 120 μm × 30 μm, and are arranged in a 127 μm pitch. Further, a thickness of the transparent substrate 27 is assumed to be about 0.3 mm to 1 mm. It follows that mesh of the opaque electrode 14 of the front light 10 has a 254 μm pitch corresponding to two pixels of the liquid crystal display device 20. With a pattern width being 10 μm, area ratio that the opaque electrode occupies is (10/254) × (10/254) = 0.00155, which corresponds to open area ratio of 99.8 %.

Next, descriptions will be made of operations in the embodiment with reference to FIG. 1 to FIG. 4. When a voltage of about 5V to 15V is applied to the region between the transparent electrode 12 and the opaque electrode 14, a white light is emitted from the organic EL layer 13 sandwiched between the transparent electrode 12 and opaque electrode 14. In this case, unless some particular contrivance is made in the design of a light-emitting device, the light is isotropically emitted in every direction. As schematically shown in FIGS. 1 and 4, the light emitted in the direction of the liquid crystal display device 20 illuminates the device 20 directly. On the other hand, the light emitted in the direction of the opaque electrode 14 is once reflected by the electrode 14, and then illuminates the liquid crystal display device 20.

The light transmits through the transparent electrode 27, color filter 26, and the like. Only light component having the wavelength selected by the color filter reaches the reflective members 22. Whether surfaces of the reflective members 22 are illuminated uniformly or not depends upon positional relationship between the transparent electrode 14 (or light-emitting section) and the reflective members 22. The larger an arrangement pitch of the light-emitting section is, the greater the ununifomity of illumination distribution on the surface that the reflective members exist becomes.

Conversely, when the arrangement pitch is made smaller, an area that the opaque electrode occupies becomes larger.

In this case, if the front light is not used, a possibility that incident light from surrounding area reaches the reflective members becomes lower. As a result, displayed image becomes dark. Therefore, positional relationship between the opaque electrode and reflective members must be determined with utilization efficiency of the ambient light and illumination distribution obtained by the light of the front light taken into consideration. In view of the above situation, positional relationship between the mesh-like opaque electrode (or light-emitting section) and reflective members (and the color filter) is controlled such that one grid of the mesh corresponds to four pixels, as shown in FIG. 2.

A distance from the light-emitting section of the front light 10 to the reflective members 22 of the liquid crystal display device is 0.6 mm or more, and directivity of the light is not high as described above. As a result, the reflective members 22 are illuminated uniformly. Naturally, since the target utilization efficiency of the ambient light and the amount of the light of the front light and the like depend on the environment where the display device is actually used, effect of the present invention are not limited to the numeric values described above.

The light that reaches the reflective members 22 transmits, in turn, through the liquid crystal 24, color filter 26 and the like in the opposite order. The light then transmits through the region that is not occupied by the opaque electrode 14 of the front light 10, and finally reaches an observer (not shown). The amount of the traveling light is controlled by the voltage applied to the liquid crystal 24, so that arbitrary images can be displayed.

In the liquid crystal display device of the present invention, the front light is a planar light source in which the light-emitting section and the transparent section are arranged with regularity. Therefore, regardless of whether the front light is used or not as an auxiliary light, high display capability can be maintained. More specifically, when the front light is used as an auxiliary light, entire display area of the liquid crystal display device is uniformly illuminated.

Further, since a particular mechanism for changing the direction of outside light is not provided, the problem that the conventional reflective-type liquid crystal display device with a front light has been faced with, that is, the problem that display capability degrades due to dispersion of outside light and adhesion of a foreign matter such as dust, oil, or the like to a surface of the front light can be solved. Further, almost all the light emitted from the front light is used for illuminating the liquid crystal display device, and almost all the reflected light reaches the observer. Therefore, it can be said that high utilization efficiency of light can be obtained when the front light is used.

While a single material is used for the opaque electrode 14 in the above description, the surface of the opaque electrode 14 on the side that does not face the organic EL layer 13 may have light absorption characteristics by a process such as anodizing the aluminum surface and coating the resultant surface with a black pigment. In this case, a light component of the incident light that cannot transmit through the front light is absorbed by the opaque electrode. This prevents a contrast of the liquid crystal display device from being reduced owing to reflection by the opaque electrode, thereby obtaining a high contrast.

In the configuration of the front light described above, only the opaque electrode except the terminal area is patterned in a mesh-like shape, but the present invention does not put limitations on the shape of the components of the front light. More specifically, same advantages can be obtained even if the organic EL layer and the transparent electrode, which constitute the front light, are also patterned. FIGS. 5 to 7 are schematic sectional view showing a modification of the front light. In these drawings, the same parts as those in the embodiment shown in FIG. 1 (b) are indicated by the same reference numerals.

In the front light 10b shown in FIG. 5, the patterned organic EL layer 14b is disposed under the opaque electrode 14b. In the front light 10c of FIG. 6, patterned transparent electrode 12c is disposed under the opaque electrode 14c. In the front light 10d of FIG. 7, both the transparent electrode 12d and organic EL layer 14d are patterned, and are disposed under the opaque electrode 14d. Operations and effects of the front lights configured as above are the same as those of the embodiment of FIG. 1.

It should be noted that the example of FIG. 7 differs from other examples in the point that the side surfaces in the film thickness direction of the organic EL layer 13d are covered by the opaque electrode 14d, so that the light to be headed in this direction is blocked. In addition, an extra process is required to pattern an electrode material of the front light by photolithography in the modifications shown in FIGS. 5 to 7. The increase in the number of process leads to increase in the manufacturing cost. However, in the case of FIGS. 6 and 7, a removal of overlap in the transparent electrode and organic EL layer in the terminal area increases utilization efficiency of the light of the front light.

In the configuration shown in FIG. 4, the organic EL layer 13 and transparent electrode 12 also exist in the lower portion of the terminal area formed by patterning the opaque electrode 14. Accordingly, light is also emitted from this area. However, since the terminal area is formed in the region that the reflective members 22 of the liquid crystal display device do not exist, the light emitted from the terminal area is not utilized for display. As a matter of course, it is possible to utilize this light for display other than liquid crystal display, or for illuminating outside.

Further, in the embodiment described above, mesh-like emitting areas of the front light are arranged to correspond to the reflective members. As a modification of the present embodiment, as shown in FIG. 8, the mesh-like opaque electrode of the front light 10e may be inclined at a 45 degree angle with respect to the reflective members 22 of the liquid crystal display device 20. An object of this configuration is to prevent red brightness of the opaque electrode from decreasing visually depending on, for example, the amount of area that the opaque electrode overlaps with a part of pixel column R in accordance with a change in view angles, when the observation of the pattern of FIG. 2 is made from above. Accordingly, alignment angle between the opaque electrode and reflective members is not limited to 45 degree. Note that a moiré fringe, which is explained later, occurs depending on the above alignment angle, arrangement pitch of the opaque electrode or the like. The moiré fringe lowers display capability of the liquid crystal display device.

Generally, when one pattern having a predetermined cycle is superposed on the other pattern having a different cycle, a regular pattern (moiré fringe) defined by the two cycles occurs. Also, in the case where the conventional front light is superposed on the

liquid crystal display device, such a moiré fringe may occur due to difference between the regulated pattern provided in the light guiding member and that of the components of the liquid crystal display device. In the above-mentioned publication showing the prior art, the condition of the components is determined by some experiments so that occurrence of a moiré fringe is reduced to an acceptable level. More specifically, angle between the one-dimensional pattern provided in the light guiding member and pixel arrangement of the liquid crystal display device may be 22.5 to 25 degree. These numeric values are typical to some specific experimental conditions and do not have any universality at all. For example, these numeric values depend upon experimental conditions such as vision of an observer, brightness of the surrounding area, or the like.

It is known that a spatial frequency of one pattern may be an integral multiple of that of the other pattern in order to prevent a moiré fringe from occurring when the patterns of different cycles are superposed. The configuration shown in FIG. 2 meets this condition, that is, one pattern is set to have double the spatial frequency compared to the other. Therefore, a moiré fringe does not occur. When the meshed pattern is inclined at 45 degree, a spatial frequency spectrum of the mesh pattern that has been projected in the direction of regulated pattern of the liquid crystal display device does not have radical peaks, so that a moiré fringe become less obvious from a practical standpoint.

In the above embodiment, the opaque electrode of the front light has a mesh-like shape. However, of course, the shape is not limited to this. For example, also when a striated pattern shown in FIG. 9 or a meandering pattern is employed, the same advantages as above can be obtained.

The reflective-type liquid crystal display device having a color filter is taken as an example in the above description. However, the present invention can be applied to a monochrome reflective-type liquid crystal display device that does not have a color filter. In addition, the front light configured to emit light in the direction toward the transparent substrate is taken as an example, but the front light may emit light in the direction toward the opposite side of the transparent substrate by interchanging the position of the transparent electrode with that of the opaque electrode. As described above, various substitutions can be made without departing from the subject matter of the present invention. The configuration obtained in this manner can be regarded as a modification of the first embodiment of the present invention.

[Second embodiment of the present invention]

In a second embodiment of the present invention, divided electrodes are used for the front light. FIG. 10 is an explanatory view showing a configuration of the front light having divided electrodes. The front light of the second embodiment shown in FIG. 10 differs from that of the first embodiment in the configuration of the opaque electrode. The opaque electrode of the second embodiment is divided into three electrodes, and voltages applied to the electrodes can be controlled individually. Thus, individual application of a predetermined voltage to the three electrodes arranged in parallel with each other can set brightness of the front light at three levels in the shape of the electrode as shown in FIG. 10.

The configuration described above has an advantage that the brightness of the front light can be controlled by a simple drive circuit. The configuration of the first embodiment can also control

the brightness of the front light by adjusting a voltage value applied to the organic EL layer. However, to that end, an accurate application of the voltage is required with a correct understanding of the characteristics in applied voltage and optical output of the organic EL layer. Three digital signals can set 8 brightness values in the configuration of FIG. 10 by applying a voltage of e.g., 5V to any of the three electrodes. The digital drive described above makes an advanced amplifier circuit unnecessary. Naturally, an increase in the number of electrode can control the brightness more accurately.

In the description described above, the opaque electrode is used as an example of divided electrodes of the front light, but the same advantages can be obtained if the transparent electrode is divided into multiple electrodes. Accordingly, the configurations like this can be regarded as a modification of the second embodiment of the present invention.

[Third embodiment of the present invention]

In the second embodiment, all the divided multiple electrodes of the front light cover the substantially entire region of the display area of the liquid crystal display device. However, for example, the divided two opaque electrodes of the front light may respectively cover the separated display area of the liquid crystal display device. This configuration has an advantage that a specific area of the liquid crystal display device can be illuminated individually. This configuration is used for, for example, a partial display function of a mobile phone.

In the description described above, the opaque electrode is used as an example of divided electrodes of the front light, but the same advantages can be obtained if the transparent electrode is divided into multiple electrodes. Accordingly, the configurations like this can be regarded as a modification of the third embodiment of the present invention.

[Advantages of the Invention]

Advantages of the present invention will be described based on the embodiments. Through all the embodiments, the liquid crystal display device according to the present invention exhibits the advantages described below. According to the present invention, the liquid crystal display device can be illuminated uniformly and efficiently, so that favorable display capability can be obtained. In addition, display capability is not adversely affected even if a foreign matter is adhered to a surface of the front light. Furthermore, the number of the parts required for assembly is smaller compared to the conventional front light using the light guiding member, which can reduce the manufacturing cost.

In addition to the advantages described above, the liquid crystal display device of the second embodiment exhibits another advantage that the brightness of the front light can be controlled by a simple drive circuit.

Furthermore, the liquid crystal display device of the third embodiment exhibits another advantages that a reflective liquid crystal display device having a partial display function can be realized at a low cost, as well as the advantages in the first embodiment.

[Brief Description of the Drawings]

[FIG. 1]

Explanatory views schematically showing a configuration of the liquid crystal device using a front light according to a first

embodiment.

[FIG. 2]

An explanatory view showing positional relationship between the opaque electrode of the front light and the color filter of the liquid crystal display device, both included in the liquid crystal display device.

[FIG. 3]

An explanatory view showing a shape of the opaque electrode of the front light included in the liquid crystal display device.

[FIG. 4]

A perspective view schematically showing a configuration of a part of the front light included in the liquid crystal display device and an operation of the front light.

[FIG. 5]

A schematic sectional view showing a modification of the front light included in the liquid crystal display device.

[FIG. 6]

A schematic sectional view showing another modification of the front light included in the liquid crystal display device.

[FIG. 7]

A schematic sectional view showing still another modification of the front light included in the liquid crystal display device.

[FIG. 8]

Explanatory views showing a modification of the liquid crystal display device.

[FIG. 9]

An explanatory view showing a modification of the opaque electrode of the front light included in the liquid crystal display device.

[FIG. 10]

An explanatory view showing a shape of the opaque electrode of the front light in the liquid crystal display device using a front light of a second embodiment.

[FIG. 11]

An explanatory view showing a shape of the opaque electrode of the front light in the liquid crystal display device using a front light of a third embodiment.

[FIG. 12]

A schematic sectional view showing an embodiment of the liquid crystal display device using a conventional front light.

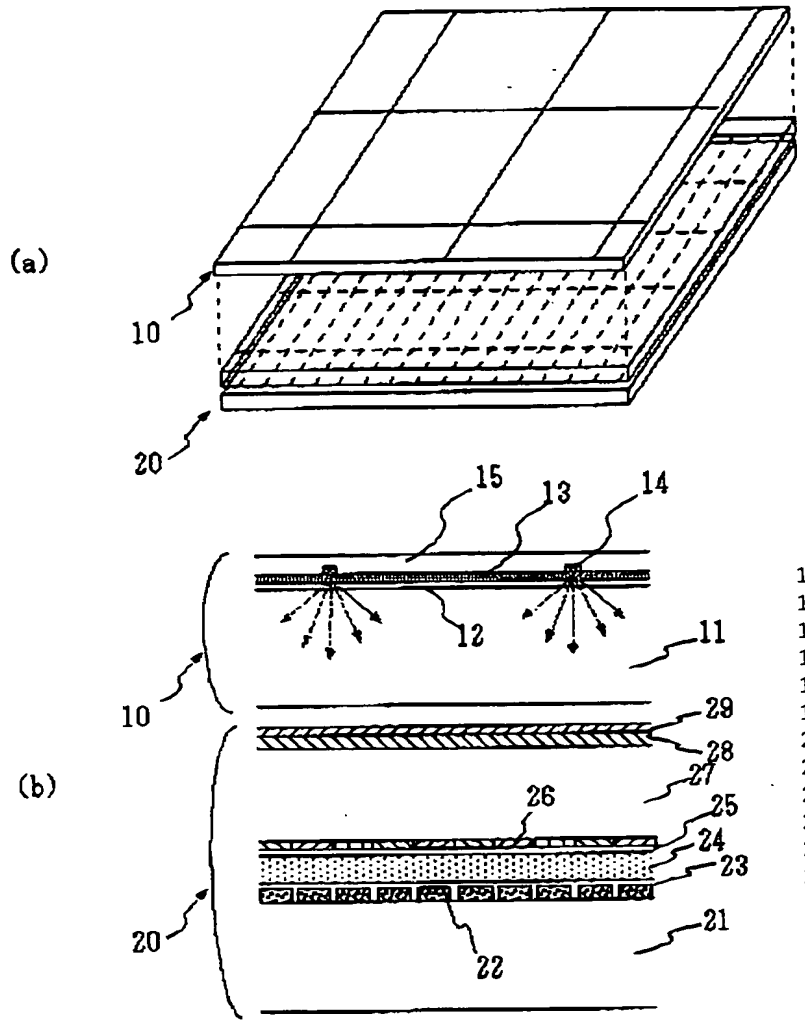
[Explanation of Reference Symbols]

10: Front light
11: Transparent substrate
12, 27: Transparent electrode
13: Organic EL layer
14: Opaque electrode
15: Protection layer
20: Liquid crystal display device
21: Electrode substrate
22: Reflective member
23, 25: Orientation film
24: Liquid crystal
26: Color filter
28: Retardation film
29: Polarizing plate
30: Diffraction grating for color separation
110: Front light
111: Linear light source
112: Light guiding member
112a: Incident surface
112b: Reflection surface

112c: Emission surface
113: Protection surface
120: Liquid crystal display device
121: Electrode substrate
122: Reflective member
123: Liquid crystal
124: Transparent substrate
125: Retardation film
126: Polarizing plate

[Name of the document] Drawings

[FIG. 1]



10: Front light
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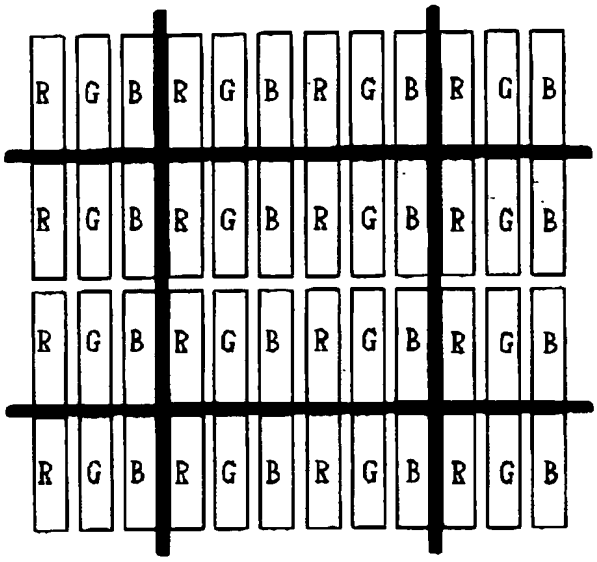
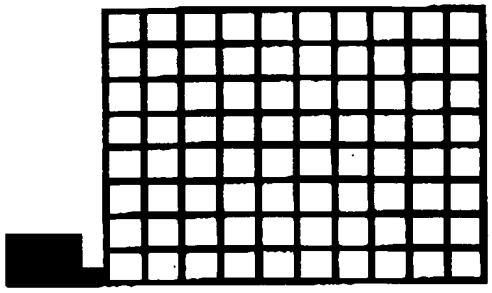
14: Opaque electrode
15: Protection layer
20: Liquid crystal display device
21: Electrode substrate
22: Reflective member
23: Orientation film
24: Liquid crystal
25: Orientation film
26: Color filter
27: Transparent substrate
28: Retardation film
29: Polarizing plate

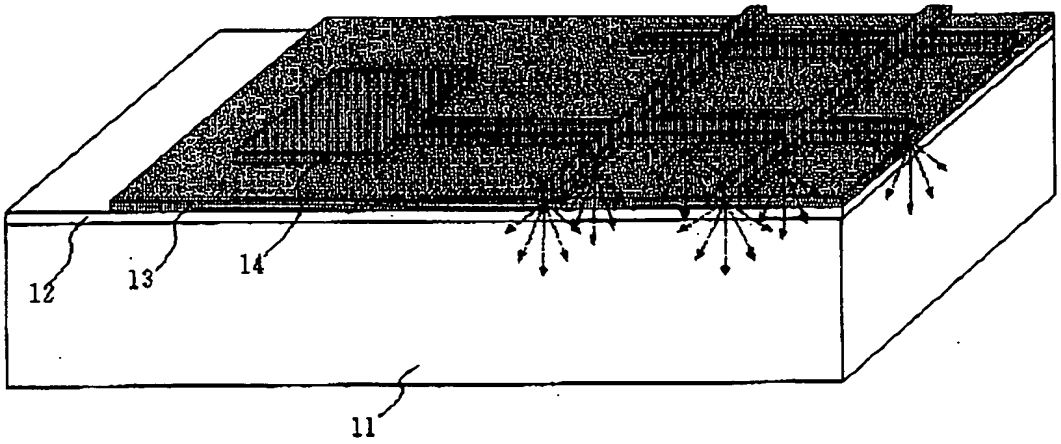
[FIG. 2]



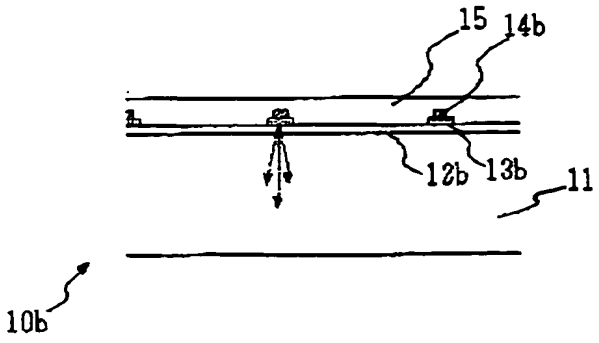
[FIG. 3]



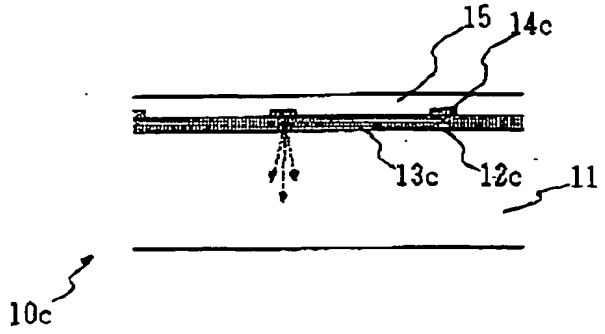
[FIG. 4]



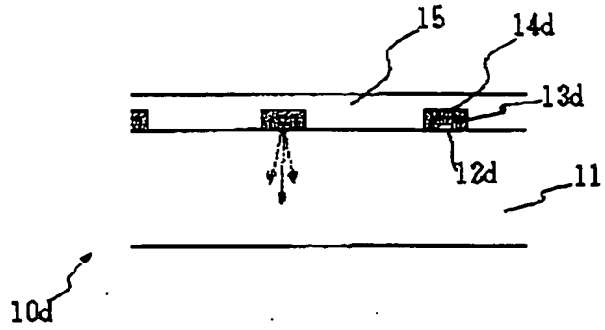
[FIG. 5]



[FIG. 6]

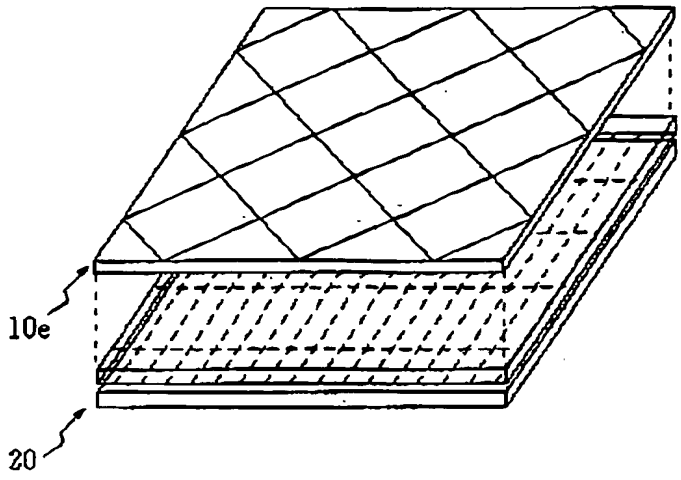


[FIG. 7]

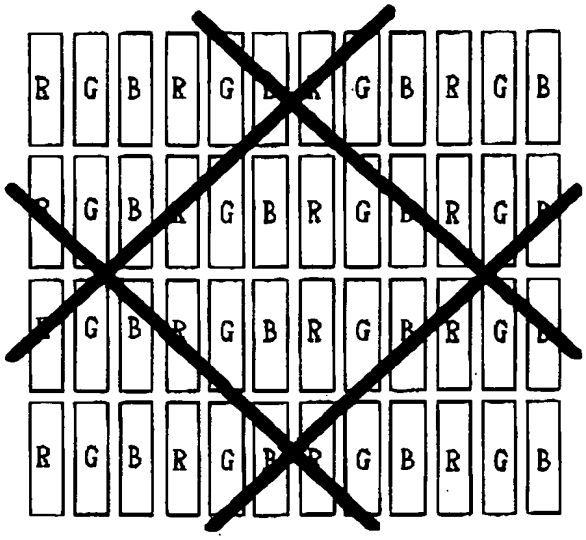


[FIG. 8]

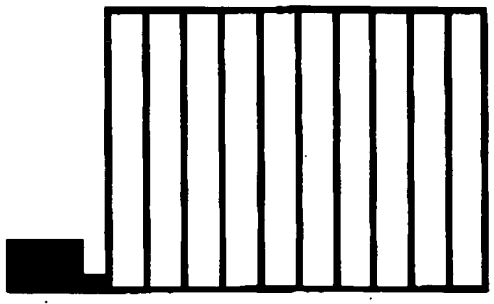
(a)



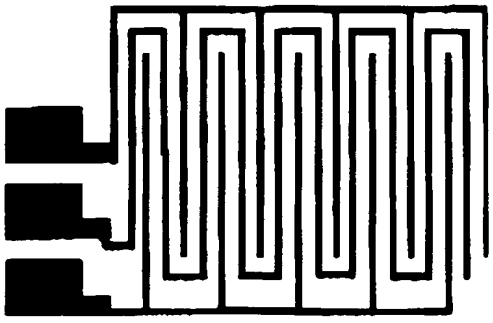
(b)



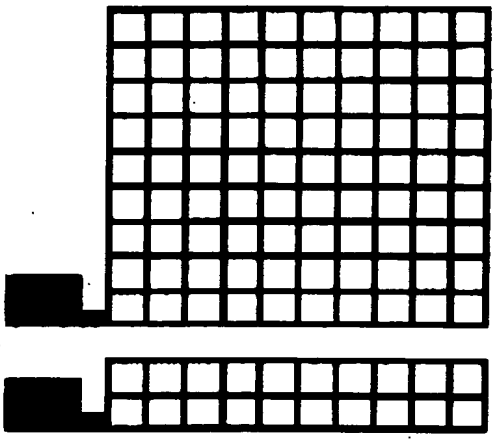
[FIG. 9]



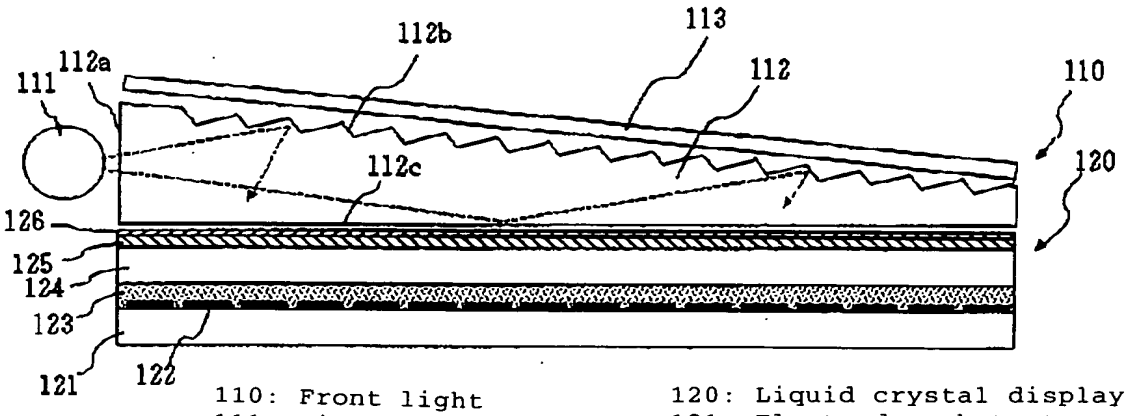
[FIG. 10]



[FIG. 11]



[FIG. 12]



110: Front light
111: Linear light source
112: Light guiding member
112a: Incident surface
112b: Reflection surface
112c: Emission surface
113: Protection surface
120: Liquid crystal display device
121: Electrode substrate
122: Reflective member
123: Liquid crystal
124: Transparent substrate
125: Retardation film
126: Polarizing plate

[Document] Abstract

[Abstract]
[Object]

By using a conventional front light installed at the edge portion of the light guiding members, it is difficult to illuminate a reflective-type crystal display device efficiently and uniformly. In addition, display capability degrades if a foreign matter adheres to a surface of the light guiding member. Also, it is difficult to realize the reflective-type crystal display device having a partial display function at a low cost.

[Means for Achieving the Object]

An illumination means disposed in front of a display surface of the liquid crystal display device for emitting light in the direction toward the liquid crystal display device, wherein the illumination means has a plurality of light-emitting area, and a plurality of light-transmitting area, a surface opposing to the light-emitting area of the device has light absorbing property. The plurality of reflection means are arranged in a first arrangement pitch, a plurality of the light-transmitting areas are arranged in a second arrangement pitch, and the second arrangement pitch is an integral multiple of the first arrangement pitch. An angle between arrangement direction of the plurality of reflection means of the liquid crystal display device and that of the plurality of light-emitting areas of the illumination means is set at any degree other than 0. A plurality of the illuminating areas of the illumination means is controlled individually as two or more groups of light-emitting areas.

[Elected Figure] FIG. 1

4/7

平成１２年　３月　２日

柳川特許事務所

柳川　信　　様

日本電気株式会社

知的財産部長 京本　直樹

特許出願のご依頼

拝啓　時下ますますご清栄のこととお喜び申し上げます。

さて、貴幣間で締結の委任業務契約書第２条に基づき、下記のとおり出願をご手配くださるようお願い申し上げます。

敬具

記

１．依頼発明

依頼番号	０８８８１－０２５２４
整理番号	３４８０３４１１
審査請求	保留
出願種別	通常
出願人形態	ＮＥＣ単独
外国出願	外国出願する
Ｓ指定	なし
出願人	会社名　日本電気株式会社　識別番号　０００００４２３７
出願期限	平成１２年　４月　３日
当部技術担当者	佐々木　久雄
届出区分	新：出願直前の明細書点検が必要
届出の形態	明細書全文による届出

２．納品

出願後、一両日中に電子納品でお願いします。

３．その他

EXHIBIT "E"

5/7

①ＪＩＳ１０出願の場合は出願番号通知書を入手後直ちに出願番号入力を行ってください。

以下の書類はWWWにてご確認ください。

1．業務発明届出・譲渡書

2．発明説明書（または届出明細書）および図面の草案

3．先行技術文献

以上

研究開発技術本部

情報特許部

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Ｔ　Ｅ　Ｌ：044-856-2052

Ｆ　Ａ　Ｘ：

March 2, 2000

To: Yanagawa Patent Firm
Mr. Makoto Yanagawa

NEC Corporation
IP Department Manager Naoki Kyomoto

Request for Patent Application

Dear Sirs:

Please arrange the application based on the business contract article 2 signed between our company and your firm.

Sincerely

Note

1. Requested invention

Request No. 08881-02524
Serial No. 34803411
Request for examination: Suspended
Application type: Normal
Applicants: NEC independent
International Application: Requested
S-assignment: None

Applicant:	Name	Identification No.
	NEC Corporation	000004237

Application due date: April 3, 2000
IP Department, Engineer in charge: Hisao Sasaki
Type of disclosure: Requested to review just before application.
Form of disclosure: Disclose by complete specification

2. Delivery

Please deliver electrically in few days after the

EXHIBIT "F"

application.

3. Others

① Please enter an application number just after the Application Number Notice has been received in the case of JIS10 application.

Please confirm the following documents by WWW.

1. "Employee Invention Report-Assignment-Opinion"
2. Description of Invention (or draft specification) and draft drawings.
3. Prior art

End of message

Research and Development Center
Patent Information Department

Hisao Sasaki E-Mail: sasaki@nppi.cl.nec.co.jp
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7/7

From: fujieda@ddl.cl.nec.co.jp
Date: Fri, 21 Apr 2000 09:30:23 +0900 (JST)
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Cc: fujieda@ddl.cl.nec.co.jp
Subject: MEISAISYO KAKUNIN KAITOU
X-UIDL: 303030303030303031313131343734

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＊＊＊　出願明細書原稿に対する確認（回答）　＊＊＊

柳川特許事務所（柳川　信）　殿

04月20日付のお問い合わせに関して、下記の通り回答いたしますので、ご処理くださるようよろしくお願いいたします。

記

１．整理番号　34803411
２．発明の名称　フロントライト及び液晶表示装置
３．回答期限　2000.04.25
４．回答内容　出願ＯＫ

以　上

問い合わせ先

発信者氏名　藤枝　一郎　所属　ＣＯ・（機デ研）
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EXHIBIT "G"

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Subject: Response to draft specification
X-UIDL: 303030303030303031313131343734

TO: yanapat@mui.biglobe.ne.jp
CC: fujieda@ddl.cl.nec.co.jp

*** Confirmation of draft specification for application (Response) ***

Dear (Mr. Makoto Yanagawa), Yanagawa Patent Firm

In response to your inquiry dated April 20, 2000, I will respond to you as follows:

Note

1. Serial No. 34803411
2. Title of the Invention: Front Light and Liquid Crystal Display Device
3. Response due date: 2000.04.25
4. Response: Application OK

End of message

Any inquiry should be directed to:
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EXHIBIT "H"

CERTIFICATION

I, Harumasa ISHIZAKI of FUSOH PATENT FIRM, Rindo Building, 5F, 37, Kanda-Higashimatsushita-cho, Chiyoda-ku, Tokyo, 101 Japan, hereby certify that I am the translator of the accompanying certified official copy of the patent application No. 2000-125056 for a patent filed in Japan on April 26, 2000 and certify that the following is a true and correct translation to the best of my knowledge and belief.

Dated this 9th day of November 2003

H. Ishizaki

Harumasa Ishizaki

EXHIBIT "J"

PATENT OFFICE

JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this Office.

DATE OF APPLICATION April 26, 2000

APPLICATION NUMBER Patent Application No.2000-125056

APPLICANT(S) NEC Corporation

DATE February 2, 2001

Commissioner,

Patent Office Kozo OIKAWA

Certificate No. Patent-2001-3002658

Date of Application April 26, 2000

Serial Number=34803411 Patent Application 2000-125056 Page: 1/1

[NAME OF DOCUMENT] APPLICATION FOR PATENT

[SERIAL NO.] 34803411

[DATE OF FILING] April 26, 2000

[ADDRESSEE] Commissioner, Patent Office

[INTERNATIONAL PATENT CLASSIFICATION] G02F 1/133

[INVENTOR]

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[PATENT ATTORNEY]

[NAME] Shin Yanagawa

[PREPAYMENT NUMBER] 030982

[AMOUNT OF PAYMENT] 21,000Yen

[LIST OF DOCUMENTS ATTACHED]

[NAME OF DOCUMENT] SPECIFICATION.....1

[NAME OF DOCUMENT] DRAWINGS.....1

[NAME OF DOCUMENT] ABSTRACT.....1

[REQUEST OF PROOF] REQUESTED

[Document] Specification

[Title of the Invention]

LIQUID CRYSTAL DISPLAY DEVICE

[What is Claimed is:]

[Claim 1] A liquid crystal display device comprising:

a liquid crystal display device having a plurality of reflection means; and

illumination means which is disposed in front of a display surface of the liquid crystal display device and which emits light in the direction toward the plurality of reflection means, the device characterized in that the illumination means has a light-emitting area including a material capable of emitting light when being supplied with a current, and light-transmitting area.

[Claim 2] The liquid crystal display device according to claim 1, characterized in that a surface of the light-emitting area of the illumination means on the side that does not face the liquid crystal display device has light absorbing characteristics.

[Claim 3] The liquid crystal display device according to claim 1 or 2, characterized in that the plurality of reflection means of the liquid crystal display device are arranged in a first arrangement pitch, a plurality of the light-emitting areas of the illumination means and a plurality of the light-transmitting areas are arranged in a second arrangement pitch, and the second arrangement pitch is an integral multiple of the first arrangement pitch.

[Claim 4] The liquid crystal display device according to claim 1, characterized in that an angle between arrangement direction of the plurality of reflection means of the liquid crystal display device and that of the plurality of light-emitting areas of the illumination means is set at any degree other than 0.

[Claim 5] The liquid crystal display device according to any of claims 1 to 4, characterized by comprising means for individually controlling two or more grouped light-emitting areas of the illumination means.

[Claim 6] The liquid crystal display device according to any of claims 1 to 5, characterized in that the illumination means includes a transparent electrode, organic EL material, and opaque electrode which are stacked on a transparent substrate.

[Claim 7] The liquid crystal display device according to claim 6, characterized in that the illumination means has a structure in which the transparent electrode is formed on the transparent substrate, the organic EL material is formed on the transparent electrode, and the patterned opaque electrode is formed on the organic EL material.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a liquid crystal display device mounted in a device, such as a mobile phone or personal digital assistance like a notebook computer, and

more particularly, to a reflective-type liquid crystal display device using a front light as an auxiliary light source.

[0002]

[Prior Art]

Reflective-type liquid crystal display devicees using a front light have been disclosed in Jpn. Pat. Appln. Laid-Open Publication No. 2000-29008, Jpn. Pat. Appln. Laid-Open Publication No. 2000-19330, Jpn. Pat. Appln. Laid-Open Publication No. 11-326903, and the like. Of these, the reflective-type liquid crystal display device using a front light disclosed in Jpn. Pat. Appln. Laid-Open Publication No. 2000-29008 is taken as an example, and will be explained below.

[0003]

A conventional reflective-type liquid crystal display device using a front light comprises a liquid crystal display device 120 including a reflective electrode 122 and the like, and a front light 110. As shown in FIG. 12, the front light 110 is disposed on the liquid crystal display device 120. The front light 110 comprises a linear light source 111 which is constituted by linearly arranging a cold-cathode tube, light-emitting diode (LED), or the like, and which is disposed at an end portion of a light guiding member 112. Further, in this example, the side surface of the light guiding member 112 that does not face the liquid crystal display device 120 is processed in a staircase

pattern, and a protection member 113 is disposed on the light guiding member 112.

[0004]

Here is the operation of the device configured as above. The light emitted from the light source 111 enters inside of the light guiding member 112 through a side surface 112a thereof. The light is then reflected by a reflective surface 112b, so that the direction of progress of the light is changed. Thereafter the light is emitted from an emission surface 112c and enters the liquid crystal display device 120. The light that enters the liquid crystal display device 120 then transmits through a polarizing plate 124, retardation film 125, transparent substrate 124, and liquid crystal 123 in the mentioned order. Finally, the light is reflected by reflective members 122, transmits through the above-mentioned members in reverse order, and is emitted from the liquid crystal display device 120.

[0005]

Amount of the emitted light is controlled by arrangement direction of liquid crystal molecules existed in an upper portion of the reflective members 122. Therefore, an individual control of the respective reflective members can adjust the voltage to be applied to the liquid crystal, which allows arbitrary patterns to be displayed. The light emitted from the liquid crystal display device 120, after transmitting through the front light 110, reaches an observer (not shown). In the configuration shown in FIG. 12,

the protection member 113 prevents the reflective surface 112b from being damaged.

[0006]

[Objects of the Invention]

The conventional reflective-type liquid crystal display device using a front light is configured as follows. The light emitted from the light source, which is disposed at an end portion of the light guiding member, propagates through inside of the light guiding member. Then the traveling direction of the light is changed at the surface of the light guiding member, and finally the light illuminates the reflective-type liquid crystal display device. Here, designing a mechanism (e.g., processing the surface into a step-like or prism shape) for taking the light out of the light guiding member is very important. However, it is difficult to uniformly illuminate the entire display area of the liquid crystal display device.

[0007]

In addition, when an image is displayed by reflecting surrounding outside light, the mechanism described above also changes a traveling direction of the outside light. It follows that display capability may deteriorate when the front light is not used as an auxiliary light source. Further, when a foreign matter such as dust, oil, or the like is adhered to a surface of the light guiding member of the front light, light is further dispersed in that portion, which makes it difficult to obtain an uniform illumination.

The light emitted from the light source leaks from the side surface of the light guiding member that does not face the liquid crystal display device. Therefore, the light utilization efficiency is low.

[0008]

Some liquid crystal display devices have a function (hereinafter, referred to as "partial display") of displaying information such as time, condition of communication environment, or the like using only a part of display area, as popularized in the display function of, for example, a mobile phone. However, a conventional front light cannot select for illumination only the area to be displayed.

[0009]

The present invention has been contrived in view of the above situation, and an object thereof is to realize, at a low cost, a reflective-type liquid crystal display device comprising a front light, which can efficiently and uniformly illuminate a liquid crystal display device and whose display capability is not adversely affected even if a foreign matter is adhered to a surface of the front light.

[0010]

Another object of the present invention is to realize a reflective-type liquid crystal display device having a partial display function at a low cost.

[0011]

[Means for Achieving the Objects]

According to the liquid crystal display device as defined in claim 1 of the present invention characterized by:

A liquid crystal display device comprising:

a liquid crystal display device having a plurality of reflection means; and

illumination means which is disposed in front of a display surface of the liquid crystal display device and which emits light in the direction toward the plurality of reflection means, the device characterized in that the illumination means has a light-emitting area including a material capable of emitting light when being supplied with a current, and light-transmitting area.

[0012]

According to the liquid crystal display device as defined in claim 2 of the present invention characterized in that a surface of the light-emitting area of the illumination means on the side that does not face the liquid crystal display device has light absorbing characteristics.

[0013]

According to the liquid crystal display device as defined in claim 3 of the present invention characterized in that the plurality of reflection means of the liquid crystal display device are arranged in a first arrangement pitch, a plurality of the light-emitting areas of the illumination means and a plurality of the light-transmitting areas are arranged in a second arrangement pitch, and the second

arrangement pitch is an integral multiple of the first arrangement pitch.

[0014]

According to the liquid crystal display device as defined in claim 4 of the present invention characterized in that an angle between arrangement direction of the plurality of reflection means of the liquid crystal display device and that of the plurality of light-emitting areas of the illumination means is set at any degree other than 0.

[0015]

According to the liquid crystal display device as defined in claim 5 of the present invention characterized by comprising means for individually controlling two or more grouped light-emitting areas of the illumination means.

[0016]

According to the liquid crystal display device as defined in claim 6 of the present invention characterized in that the illumination means includes a transparent electrode, organic EL material, and opaque electrode which are stacked on a transparent substrate.

[0017]

According to the liquid crystal display device as defined in claim 7 of the present invention characterized in that the illumination means has a structure in which the transparent electrode is formed on the transparent substrate, the organic EL material is formed on the transparent electrode, and the patterned opaque electrode is formed on

the organic EL material.

[0018]

[Embodiments]

Embodiments of the present invention will be described below with reference to the accompanying drawings. FIGS. 1 (a) and 1 (b) are explanatory views schematically showing main components of a liquid crystal display device and their arrangements in a first embodiment of the present invention. The liquid crystal display device according to the present invention comprises a liquid crystal display device 20 and a front light 10 disposed above the device 20, as shown in FIG. 1 (a). As shown in the cross-sectional view of FIG. 1 (b), the front light 10 is formed by stacking, on a transparent substrate 11, a transparent electrode 12, electroluminescence (EL) layer 13, which is made of an organic material, and opaque electrode 14 in this order. A protection layer 15 is provided on a surface of the front light 10.

[0019]

In the liquid crystal display device 20, a transparent substrate 21 including a plurality of reflective members 22 and an orientation film 23, and a transparent substrate 27 including a color filter 26 and an orientation film 25 sandwich a liquid crystal 24. FIG. 2 is an explanatory view showing positional relationship between the opaque electrode 14 of the front light 10 and the color filter 26 of the liquid crystal display device 20. As shown in FIG. 3, the

opaque electrode 14 of the front light 10 has a mesh-like shape, and has a connection terminal for applying voltage. FIG. 2 shows that one grid of the opaque electrode 14 of the front light 10 corresponds to four pixels of the liquid crystal display device 20. As schematically shown in FIG. 2, the ratio of area that the opaque electrode 14 occupies should be extremely small.

[0020]

FIG. 4 is an explanatory view showing a configuration in the vicinity of the terminal for applying voltage to two electrodes (opaque electrode 14 and transparent electrode 12) of the front light 10. As shown in FIG. 4, the transparent electrode 12 is uniformly formed on a surface of the transparent substrate 11, and a substantially entire surface thereof except the portion where the terminal is disposed is covered by the organic EL layer 13, which is an insulating layer. The opaque electrode 14 formed on the organic EL layer 13 is not in contact with the transparent electrode 12. The front light 10 and liquid crystal display device 20 may be retained with an air layer interposed therebetween, and may be fixed using an optical adhesive whose refraction index is substantially the same as that of the transparent substrate.

[0021]

Hereinafter, the embodiment of the present invention will be described in detail with a material, manufacturing method, and numeric value taken as concrete examples. A

glass, plastic substrate, film substrate or the like that has a thickness in the range of 0.3 to 1 mm is used for the transparent substrate 11 of the front light 10. As for the transparent electrode 11, an indium tin oxide (ITO) film or the like is formed on the entire surface of the transparent substrate 11 by a sputtering method. In the case where ITO is used as a material of the transparent electrode 11, sheet resistance should be about 20/□, and thickness thereof about 100 nm. As for the organic EL layer 13, two-layer structure including a light-emitting layer and hole injection transporting layer, three-layer structure including an electron injection transporting layer in addition to the above two layers, and a structure in which a thin insulating film is disposed to an interface with a metal electrode are known. Any of these structures can be applied to the liquid crystal display device shown in FIG. 1 (b).

[0022]

That is, the relevant layer is referred to as organic EL layer 13 in FIG. 1 (a), but a close look confirms that various structures described above can be available. As for a method for manufacturing the organic EL layer 13, a spin coating method, vacuum deposition method, ink-jet printing method and the like are known. Corresponding to the manufacturing methods, manufacturing conditions such as a selection of the organic EL material of high molecular type, low molecular type or the like, a substrate structure, or a manufacturing method of an upper electrode are determined.

[0023]

In this embodiment, the organic EL layer 13 includes the hole injection transporting layer and light-emitting layer. As the hole injection transporting layer, for example, triarylamine derivative, oxadiazole derivative, porphyrin derivative, and the like are used. As the light-emitting layer, for example, metal complex of 8-hydroxyquinoline and derivative thereof, tetraphenylbutadiene derivative, distyrylaryl derivative, and the like are used. These materials described above are stacked together by vacuum deposition method to form the organic EL layer with the hole injection transporting layer and light-emitting layer each having thickness of about 50 nm. In this case, a metallic shadow mask is used to prevent the organic EL materials from being deposited on the terminal area of the transparent electrode 12 shown in FIG. 4. Note that desired wavelength of light can be selected through a choice of the materials. In this example, materials of the organic EL layer 13 are selected so that the organic EL layer 13 has three color components having a peak at a wavelength of 450 nm, 540 nm, and 630 nm each of which corresponds to the light's three primary colors.

[0024]

The opaque electrode 14 is formed by, for example, vacuum depositing a material such as aluminum-lithium alloy on the organic EL layer 13 through the metallic shadow mask to a thickness of about 200 nm. In order to protect the

organic EL layer 13 from oxygen or moisture, the protection layer 15 made of metal oxide, metal sulfide or the like is provided on the entire surface of the front light 10. In place of the protection layer 15, a plastic cover can be used to cover the entire device to act as a seal layer by replacing air with inactive gas such as nitrogen, argon or the like.

[0025]

Applying voltage to the region formed as described above which includes the transparent electrode 12, the opaque electrode 14, and the organic EL layer 13 sandwiched by them allows the region to act as a white light-emitting diode having three emission peaks. In this case, the voltage is applied with the transparent electrode 12 being an anode, and the opaque electrode 14 being a cathode.

[0026]

As for the liquid crystal display device 20, different kinds of reflective-type liquid crystal display devices having various kinds of method for writing signals into pixels can be used. Specifically, any of the display devices of a simple matrix type which controls orientations of liquid crystal molecules by means of orthogonal-strip electrodes, MIM (Metal-Insulator-Metal) type which applies voltage to individual pixel electrodes by means of a diode device formed by sandwiching an insulating material by metal, and TFT type which applies voltage to individual pixel electrodes by means of thin film transistor (TFT) made based

on amorphous silicon, polycrystalline silicon, and the like without using a diode may be used. In either case, a plurality of pixels are included in the liquid crystal area where voltage to be applied can individually be controlled, and are arranged with regularity.

[0027]

FIG. 1 (b) shows an example of a reflective-type liquid crystal display device capable of color display. The liquid crystal display device 20 of FIG. 1 (b) comprises an electrode substrate 21 formed by arranging a plurality of reflective members 22 with regularity on a glass substrate or the like, a transparent substrate 27 including a uniformly formed transparent electrode 27 and individualized color filter 26, and a liquid crystal 24 having a thickness of about 2 μm to 5 μm disposed between the electrode substrate 21 and the transparent substrate 27. The transparent substrate 27 and the electrode substrate 21 are positioned such that the color filter 26 and the reflective members 22 have one to one relation with each other. Further, orientation films 23, 25 are formed on the surfaces of the both substrates that contact the liquid crystal in order to arrange the liquid crystal molecules at a specific angle.

[0028]

A retardation film 28 and polarizing plate 29 are bonded in this order to the surface of the transparent substrate 27 on the side that does not face the liquid

crystal 24. The reflective members 22 have a concave and convex shape for reflecting light widely, and voltage can be applied individually to reflective members. The reflective members configured as above are formed in the manufacturing step as follows: forming a concave and convex shape on a material such as polyimide or the like by photolithography; forming a material having high reflectance such as aluminum or the like on the concave and convex shape by sputtering; and individual patterns are obtained by photolithography. A pixel, which is a unit of display in a liquid crystal display device, is constituted by three color filters R, G, and B as one set.

[0029]

As an arrangement pitch of pixels becomes small, a high resolution image can be displayed. For example, assume that each of the pixels, R, G, and B arranged as shown in FIG. 2 have a size of about 120 μm × 30 μm, and are arranged in a 127 μm pitch. Further, a thickness of the transparent substrate 27 is assumed to be about 0.3 mm to 1 mm. It follows that mesh of the opaque electrode 14 of the front light 10 has a 254 μm pitch corresponding to two pixels of the liquid crystal display device 20. With a pattern width being 10 μm, area ratio that the opaque electrode occupies is (10/254) × (10/254) = 0.00155, which corresponds to open area ratio of 99.8 %.

[0030]

Next, descriptions will be made of operations in the

embodiment with reference to FIG. 1 to FIG. 4. When a voltage of about 5V to 15V is applied to the region between the transparent electrode 12 and the opaque electrode 14, a white light is emitted from the organic EL layer 13 sandwiched between the transparent electrode 12 and opaque electrode 14. In this case, unless some particular contrivance is made in the design of a light-emitting device, the light is isotropically emitted in every direction. As schematically shown in FIGS. 1 and 4, the light emitted in the direction of the liquid crystal display device 20 illuminates the device 20 directly. On the other hand, the light emitted in the direction of the opaque electrode 14 is once reflected by the electrode 14, and then illuminates the liquid crystal display device 20.

[0031]

The light transmits through the transparent electrode 27, color filter 26, and the like. Only light component having the wavelength selected by the color filter reaches the reflective members 22. Whether surfaces of the reflective members 22 are illuminated uniformly or not depends upon positional relationship between the transparent electrode 14 (or light-emitting section) and the reflective members 22. The larger an arrangement pitch of the light-emitting section is, the greater the ununifomity of illumination distribution on the surface that the reflective members exist becomes. Conversely, when the arrangement pitch is made smaller, an area that the opaque electrode

occupies becomes larger.

[0032]

In this case, if the front light is not used, a possibility that incident light from surrounding area reaches the reflective members becomes lower. As a result, displayed image becomes dark. Therefore, positional relationship between the opaque electrode and reflective members must be determined with utilization efficiency of the ambient light and illumination distribution obtained by the light of the front light taken into consideration. In view of the above situation, positional relationship between the mesh-like opaque electrode (or light-emitting section) and reflective members (and the color filter) is controlled such that one grid of the mesh corresponds to four pixels, as shown in FIG. 2.

[0033]

A distance from the light-emitting section of the front light 10 to the reflective members 22 of the liquid crystal display device is 0.6 mm or more, and directivity of the light is not high as described above. As a result, the reflective members 22 are illuminated uniformly. Naturally, since the target utilization efficiency of the ambient light and the amount of the light of the front light and the like depend on the environment where the display device is actually used, effect of the present invention are not limited to the numeric values described above.

[0034]

The light that reaches the reflective members 22 transmits, in turn, through the liquid crystal 24, color filter 26 and the like in the opposite order. The light then transmits through the region that is not occupied by the opaque electrode 14 of the front light 10, and finally reaches an observer (not shown). The amount of the traveling light is controlled by the voltage applied to the liquid crystal 24, so that arbitrary images can be displayed.

[0035]

In the liquid crystal display device of the present invention, the front light is a planar light source in which the light-emitting section and the transparent section are arranged with regularity. Therefore, regardless of whether the front light is used or not as an auxiliary light, high display capability can be maintained. More specifically, when the front light is used as an auxiliary light, entire display area of the liquid crystal display device is uniformly illuminated.

[0036]

Further, since a particular mechanism for changing the direction of outside light is not provided, the problem that the conventional reflective-type liquid crystal display device with a front light has been faced with, that is, the problem that display capability degrades due to dispersion of outside light and adhesion of a foreign matter such as dust, oil, or the like to a surface of the front light can be solved. Further, almost all the light emitted from the

front light is used for illuminating the liquid crystal display device, and almost all the reflected light reaches the observer. Therefore, it can be said that high utilization efficiency of light can be obtained when the front light is used.

[0037]

While a single material is used for the opaque electrode 14 in the above description, the surface of the opaque electrode 14 on the side that does not face the organic EL layer 13 may have light absorption characteristics by a process such as anodizing the aluminum surface and coating the resultant surface with a black pigment. In this case, a light component of the incident light that cannot transmit through the front light is absorbed by the opaque electrode. This prevents a contrast of the liquid crystal display device from being reduced owing to reflection by the opaque electrode, thereby obtaining a high contrast.

[0038]

In the configuration of the front light described above, only the opaque electrode except the terminal area is patterned in a mesh-like shape, but the present invention does not put limitations on the shape of the components of the front light. More specifically, same advantages can be obtained even if the organic EL layer and the transparent electrode, which constitute the front light, are also patterned. FIGS. 5 to 7 are schematic sectional view

showing a modification of the front light. In these drawings, the same parts as those in the embodiment shown in FIG. 1 (b) are indicated by the same reference numerals.

[0039]

In the front light 10b shown in FIG. 5, the patterned organic EL layer 14b is disposed under the opaque electrode 14b. In the front light 10c of FIG. 6, patterned transparent electrode 12c is disposed under the opaque electrode 14c. In the front light 10d of FIG. 7, both the transparent electrode 12d and organic EL layer 14d are patterned, and are disposed under the opaque electrode 14d. Operations and effects of the front lights configured as above are the same as those of the embodiment of FIG. 1.

[0040]

It should be noted that the example of FIG. 7 differs from other examples in the point that the side surfaces in the film thickness direction of the organic EL layer 13d are covered by the opaque electrode 14d, so that the light to be headed in this direction is blocked. In addition, an extra process is required to pattern an electrode material of the front light by photolithography in the modifications shown in FIGS. 5 to 7. The increase in the number of process leads to increase in the manufacturing cost. However, in the case of FIGS. 6 and 7, a removal of overlap in the transparent electrode and organic EL layer in the terminal area increases utilization efficiency of the light of the front light.

[0041]

In the configuration shown in FIG. 4, the organic EL layer 13 and transparent electrode 12 also exist in the lower portion of the terminal area formed by patterning the opaque electrode 14. Accordingly, light is also emitted from this area. However, since the terminal area is formed in the region that the reflective members 22 of the liquid crystal display device do not exist, the light emitted from the terminal area is not utilized for display. As a matter of course, it is possible to utilize this light for display other than liquid crystal display, or for illuminating outside.

[0042]

Further, in the embodiment described above, mesh-like emitting areas of the front light are arranged to correspond to the reflective members. As a modification of the present embodiment, as shown in FIG. 8, the mesh-like opaque electrode of the front light 10e may be inclined at a 45 degree angle with respect to the reflective members 22 of the liquid crystal display device 20. An object of this configuration is to prevent red brightness of the opaque electrode from decreasing visually depending on, for example, the amount of area that the opaque electrode overlaps with a part of pixel column R in accordance with a change in view angles, when the observation of the pattern of FIG. 2 is made from above. Accordingly, alignment angle between the opaque electrode and reflective members is not limited to 45

degree. Note that a moiré fringe, which is explained later, occurs depending on the above alignment angle, arrangement pitch of the opaque electrode or the like. The moiré fringe lowers display capability of the liquid crystal display device.

[0043]

Generally, when one pattern having a predetermined cycle is superposed on the other pattern having a different cycle, a regular pattern (moiré fringe) defined by the two cycles occurs. Also, in the case where the conventional front light is superposed on the liquid crystal display device, such a moiré fringe may occur due to difference between the regulated pattern provided in the light guiding member and that of the components of the liquid crystal display device. In the above-mentioned publication showing the prior art, the condition of the components is determined by some experiments so that occurrence of a moiré fringe is reduced to an acceptable level. More specifically, angle between the one-dimensional pattern provided in the light guiding member and pixel arrangement of the liquid crystal display device may be 22.5 to 25 degree. These numeric values are typical to some specific experimental conditions and do not have any universality at all. For example, these numeric values depend upon experimental conditions such as vision of an observer, brightness of the surrounding area, or the like.

[0044]

It is known that a spatial frequency of one pattern may be an integral multiple of that of the other pattern in order to prevent a moiré fringe from occurring when the patterns of different cycles are superposed. The configuration shown in FIG. 2 meets this condition, that is, one pattern is set to have double the spatial frequency compared to the other. Therefore, a moiré fringe does not occur. When the meshed pattern is inclined at 45 degree, a spatial frequency spectrum of the mesh pattern that has been projected in the direction of regulated pattern of the liquid crystal display device does not have radical peaks, so that a moiré fringe become less obvious from a practical standpoint.

[0045]

In the above embodiment, the opaque electrode of the front light has a mesh-like shape. However, of course, the shape is not limited to this. For example, also when a striated pattern shown in FIG. 9 or a meandering pattern is employed, the same advantages as above can be obtained.

[0046]

The reflective-type liquid crystal display device having a color filter is taken as an example in the above description. However, the present invention can be applied to a monochrome reflective-type liquid crystal display device that does not have a color filter. In addition, the front light configured to emit light in the direction toward the transparent substrate is taken as an example, but the

front light may emit light in the direction toward the opposite side of the transparent substrate by interchanging the position of the transparent electrode with that of the opaque electrode. As described above, various substitutions can be made without departing from the subject matter of the present invention. The configuration obtained in this manner can be regarded as a modification of the first embodiment of the present invention.

[0047]

In a second embodiment of the present invention, divided electrodes are used for the front light. FIG. 10 is an explanatory view showing a configuration of the front light having divided electrodes. The front light of the second embodiment shown in FIG. 10 differs from that of the first embodiment in the configuration of the opaque electrode. The opaque electrode of the second embodiment is divided into three electrodes, and voltages applied to the electrodes can be controlled individually. Thus, individual application of a predetermined voltage to the three electrodes arranged in parallel with each other can set brightness of the front light at three levels in the shape of the electrode as shown in FIG. 10.

[0048]

The configuration described above has an advantage that the brightness of the front light can be controlled by a simple drive circuit. The configuration of the first embodiment can also control the brightness of the front

light by adjusting a voltage value applied to the organic EL layer. However, to that end, an accurate application of the voltage is required with a correct understanding of the characteristics in applied voltage and optical output of the organic EL layer. Three digital signals can set 8 brightness values in the configuration of FIG. 10 by applying a voltage of e.g., 5V to any of the three electrodes. The digital drive described above makes an advanced amplifier circuit unnecessary. Naturally, an increase in the number of electrode can control the brightness more accurately.

[0049]

In the description described above, the opaque electrode is used as an example of divided electrodes of the front light, but the same advantages can be obtained if the transparent electrode is divided into multiple electrodes. Accordingly, the configurations like this can be regarded as a modification of the second embodiment of the present invention.

[0050]

In the second embodiment, all the divided multiple electrodes of the front light cover the substantially entire region of the display area of the liquid crystal display device. However, for example, the divided two opaque electrodes of the front light may respectively cover the separated display area of the liquid crystal display device. This configuration has an advantage that a specific area of

the liquid crystal display device can be illuminated individually. This configuration is used for, for example, a partial display function of a mobile phone.

[0051]

In the description described above, the opaque electrode is used as an example of divided electrodes of the front light, but the same advantages can be obtained if the transparent electrode is divided into multiple electrodes. Accordingly, the configurations like this can be regarded as a modification of the third embodiment of the present invention.

[0052]

[Advantages of the Invention]

Advantages of the present invention will be described based on the embodiments. Through all the embodiments, the liquid crystal display device according to the present invention exhibits the advantages described below. According to the present invention, the liquid crystal display device can be illuminated uniformly and efficiently, so that favorable display capability can be obtained. In addition, display capability is not adversely affected even if a foreign matter is adhered to a surface of the front light. Furthermore, the number of the parts required for assembly is smaller compared to the conventional front light using the light guiding member, which can reduce the manufacturing cost.

[0053]

In addition to the advantages described above, the liquid crystal display device of the second embodiment exhibits another advantage that the brightness of the front light can be controlled by a simple drive circuit. Furthermore, the liquid crystal display device of the third embodiment exhibits another advantages that a reflective liquid crystal display device having a partial display function can be realized at a low cost, as well as the advantages in the first embodiment.

[Brief Description of the Drawings]

[FIG. 1]

Explanatory views schematically showing a configuration of the liquid crystal device using a front light according to a first embodiment.

[FIG. 2]

An explanatory view showing positional relationship between the opaque electrode of the front light and the color filter of the liquid crystal display device, both included in the liquid crystal display device.

[FIG. 3]

An explanatory view showing a shape of the opaque electrode of the front light included in the liquid crystal display device.

[FIG. 4]

A perspective view schematically showing a configuration of a part of the front light included in the liquid crystal display device and an operation of the front

light.

[FIG. 5]

A schematic sectional view showing a modification of the front light included in the liquid crystal display device.

[FIG. 6]

A schematic sectional view showing another modification of the front light included in the liquid crystal display device.

[FIG. 7]

A schematic sectional view showing still another modification of the front light included in the liquid crystal display device.

[FIG. 8]

Explanatory views showing a modification of the liquid crystal display device.

[FIG. 9]

An explanatory view showing a modification of the opaque electrode of the front light included in the liquid crystal display device.

[FIG. 10]

An explanatory view showing a shape of the opaque electrode of the front light in the liquid crystal display device using a front light of a second embodiment.

[FIG. 11]

An explanatory view showing a shape of the opaque electrode of the front light in the liquid crystal display

device using a front light of a third embodiment.

[FIG. 12]

A schematic sectional view showing an embodiment of the liquid crystal display device using a conventional front light.

[Explanation of Reference Symbols]

10: Front light

11: Transparent substrate

12, 27: Transparent electrode

13: Organic EL layer

14: Opaque electrode

15: Protection layer

20: Liquid crystal display device

21: Electrode substrate

22: Reflective member

23, 25: Orientation film

24: Liquid crystal

26: Color filter

28: Retardation film

29: Polarizing plate

30: Diffraction grating for color separation

[Document] Abstract

[Abstract]

[Object]

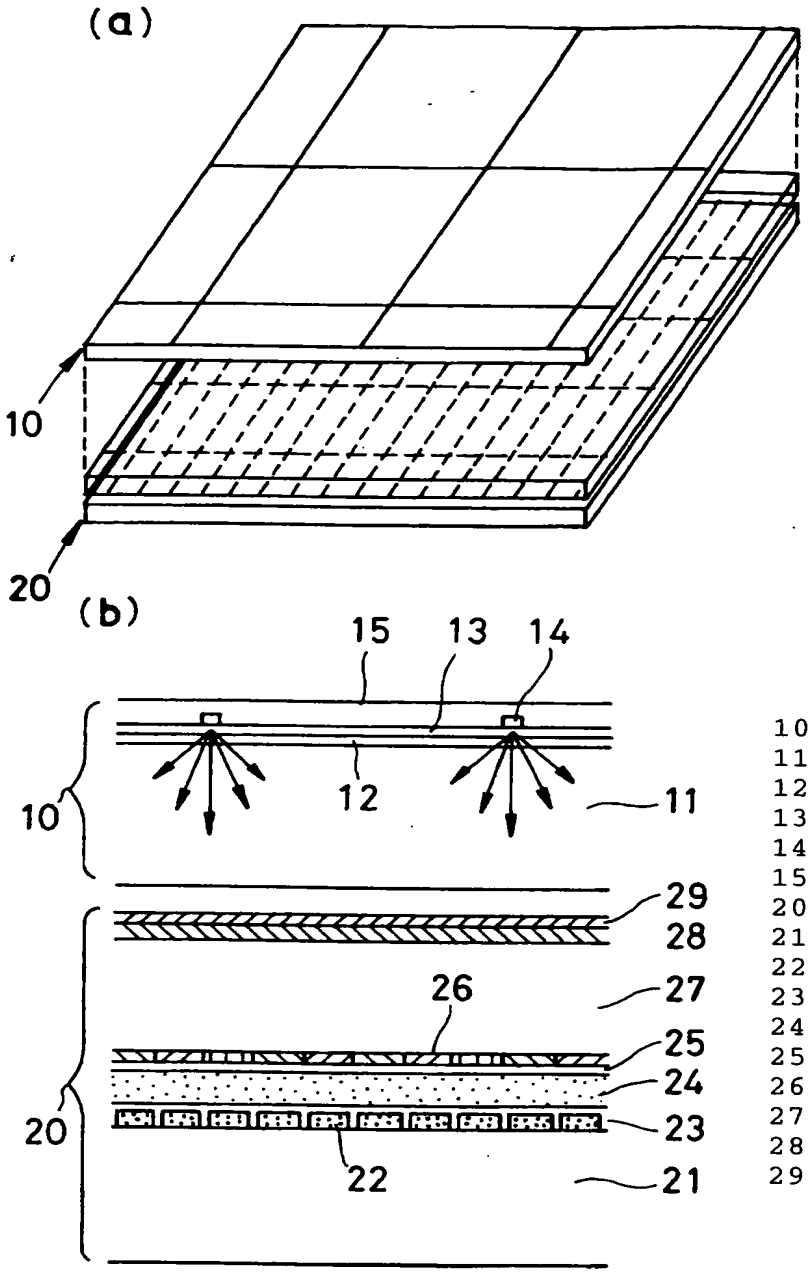
It is difficult for a conventional front light in which a light source is disposed at an end portion of a light guiding member to efficiently and uniformly illuminate a reflective-type crystal display device. In addition, display capability degrades if a foreign matter adheres to a surface of the light guiding member. An object of the present invention is to solve these problems and to realize a reflective-type crystal display device having a partial display function at a low cost.

[Means for Achieving the Object]

An illumination means 10 which is disposed in front of a liquid crystal display device 20 and which emits light in the direction toward the liquid crystal display device 20 has an area for emitting a plurality of lights and area that a plurality of lights transmit through. A surface of the light-emitting area of the illumination means on the side that does not face the liquid crystal display device has light absorbing characteristics. A plurality of reflection means 14 of the liquid crystal display device is arranged in a first arrangement pitch, a plurality of the light-emitting areas of the illumination means is arranged in a second arrangement pitch, and the second arrangement pitch is an integral multiple of the first arrangement pitch.

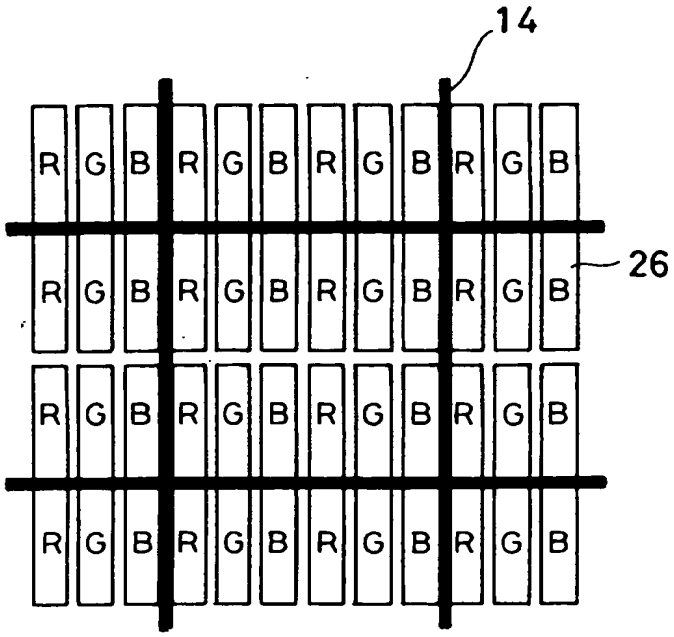
[Elected Figure] FIG. 1

[Name of the Document]
[FIG. 1]

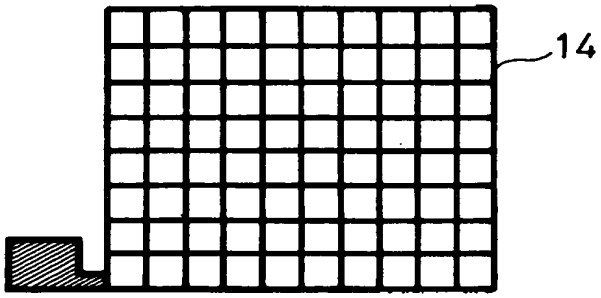


10: Front light
11: Transparent substrate
12: Transparent electrode
13: Organic EL layer
14: Opaque electrode
15: Protection layer
20: Liquid crystal display device
21: Electrode substrate
22: Reflective member
23: Orientation film
24: Liquid crystal
25: Orientation film
26: Color filter
27: Transparent substrate
28: Retardation film
29: Polarizing plate

[FIG. 2]


14
R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B
26

[FIG. 3]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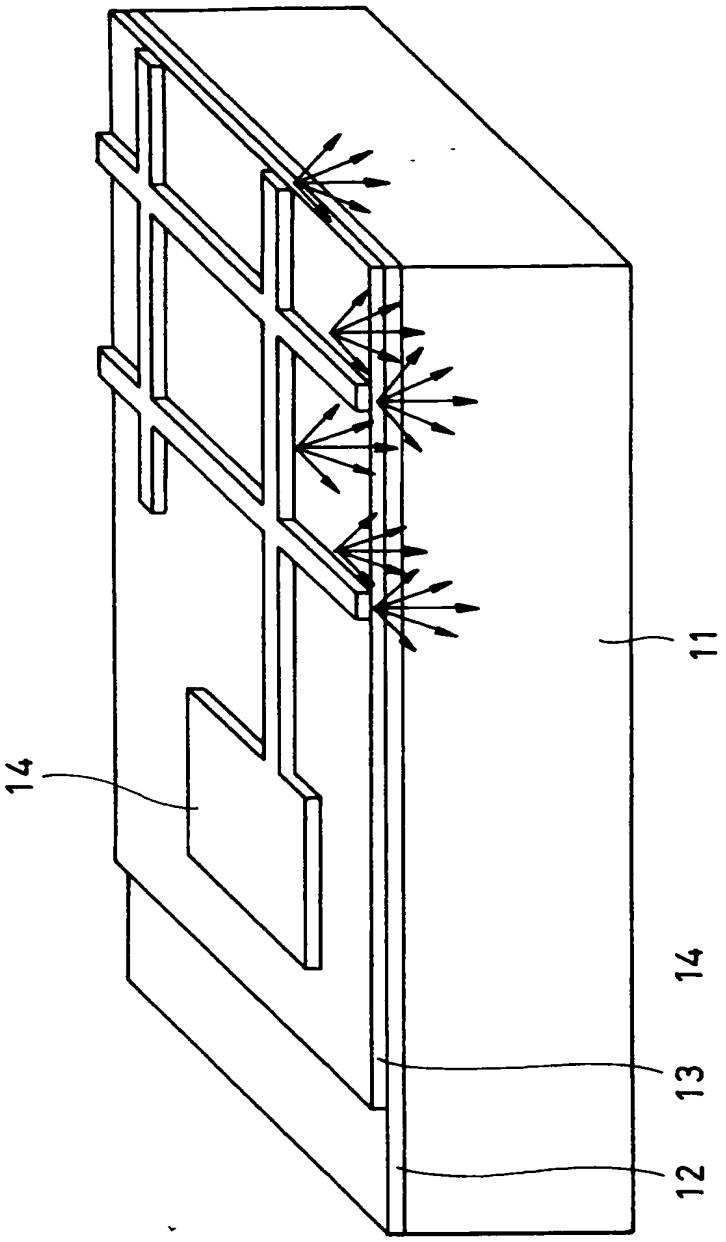
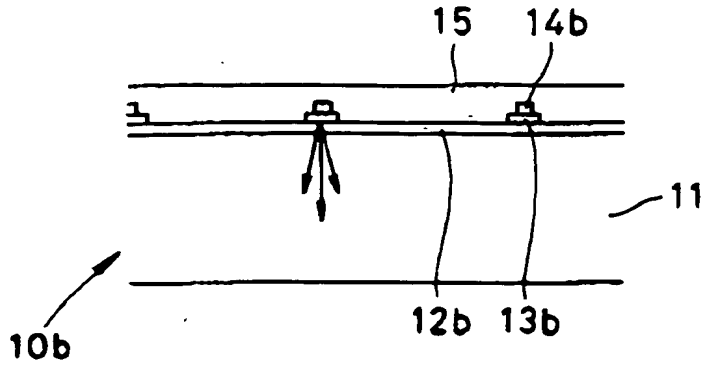
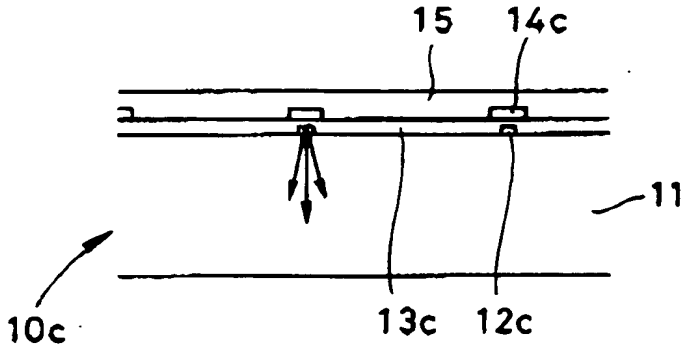
[FIG. 4]



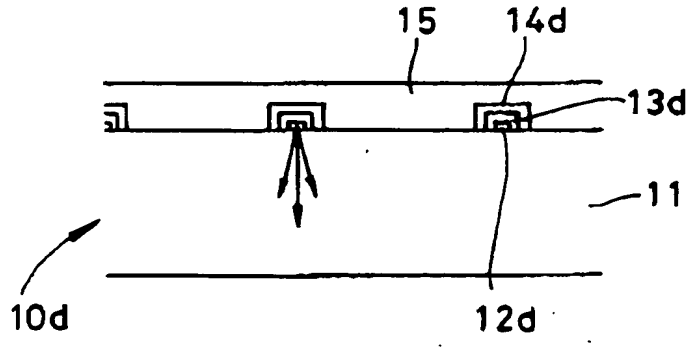
[FIG. 5]



[FIG. 6]

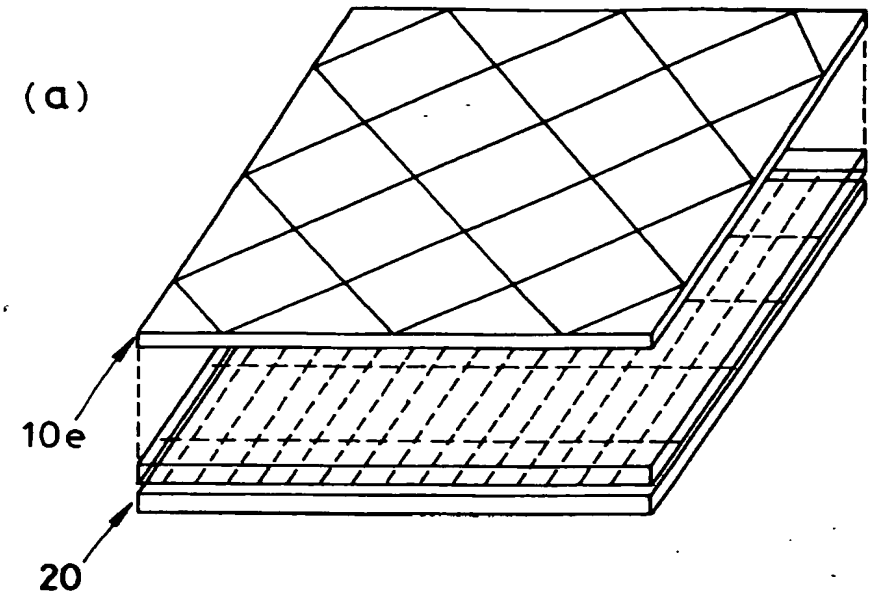


[FIG. 7]

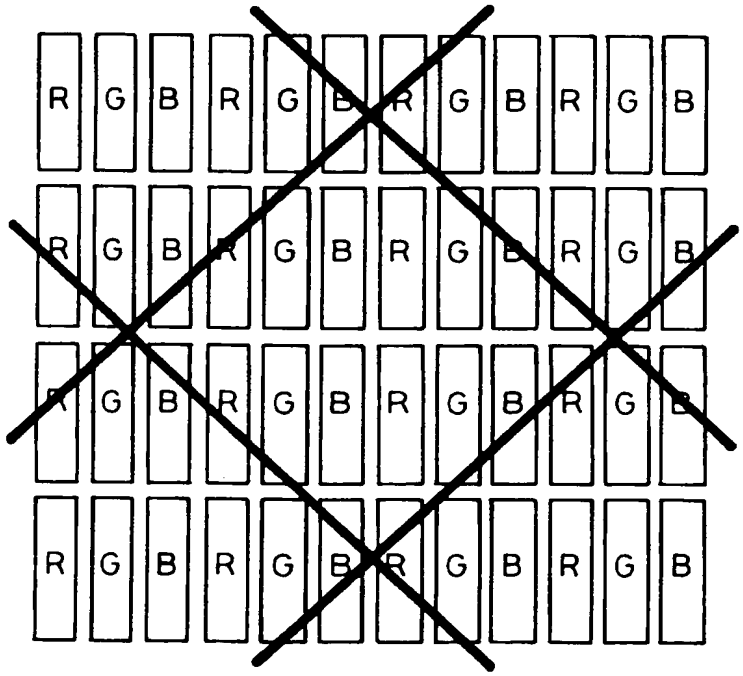


[FIG. 8]

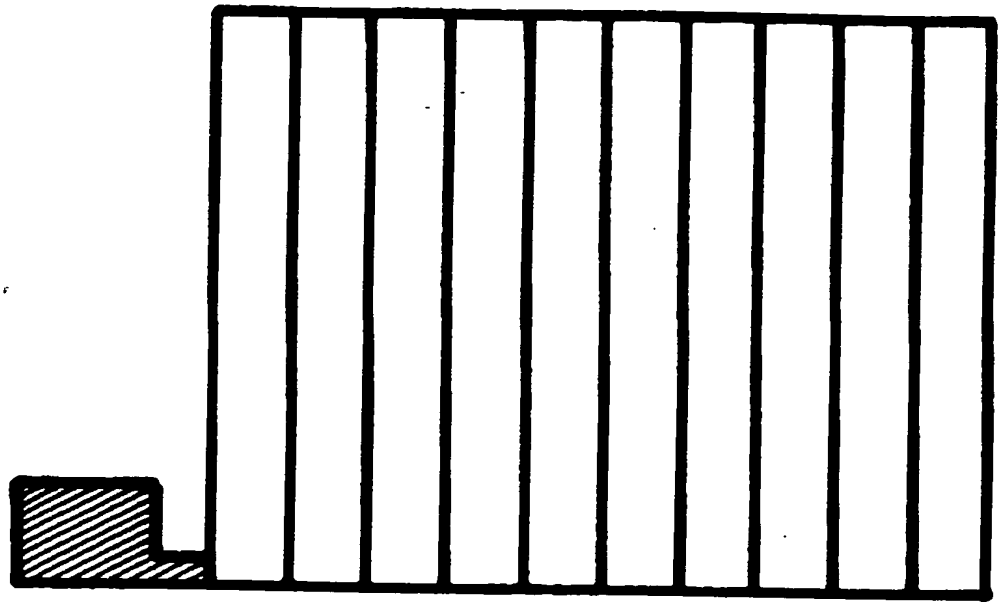
(a)


10e
20

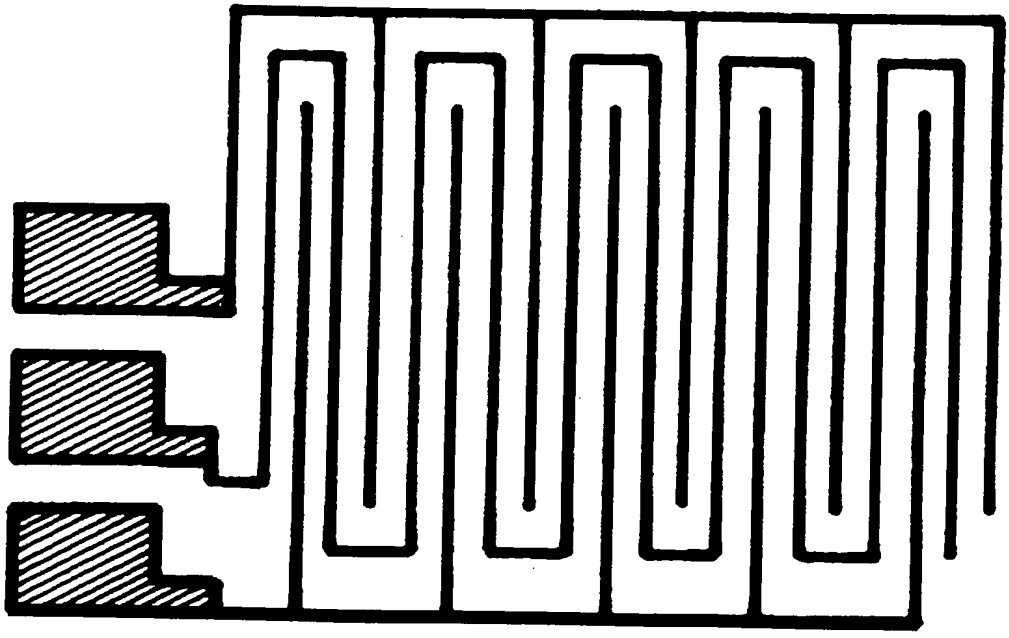
(b)


R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B
R G B R G B R G B R G B

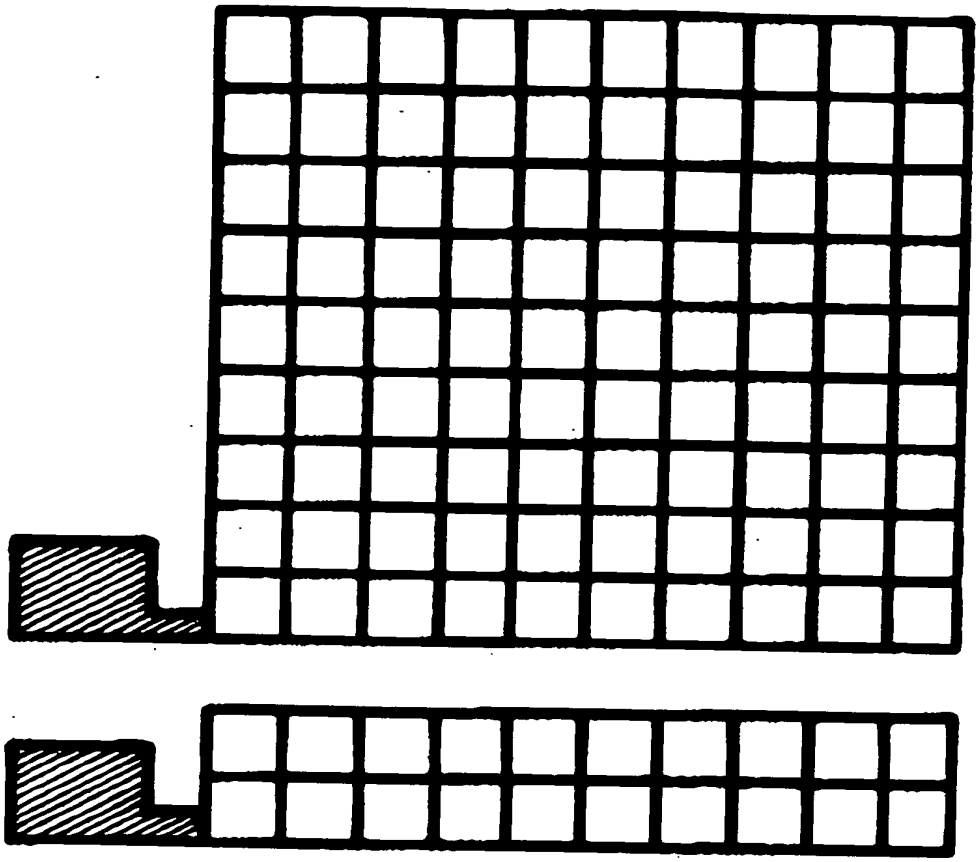
[FIG. 9]



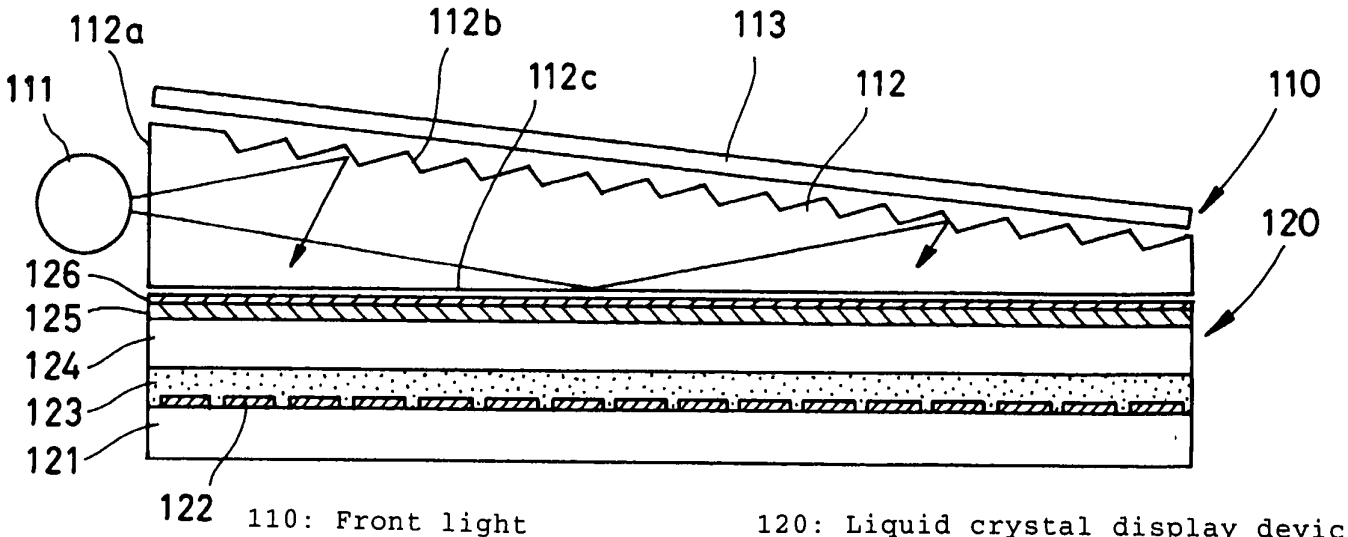
[FIG. 10]



[FIG. 11]



[FIG. 12]



110: Front light
111: Linear light source
112: Light guiding member
112a: Incident surface
112b: Reflection surface
112c: Emission surface
113: Protection surface
120: Liquid crystal display device
121: Electrode substrate
122: Reflective member
123: Liquid crystal
124: Transparent substrate
125: Retardation film
126: Polarizing plate